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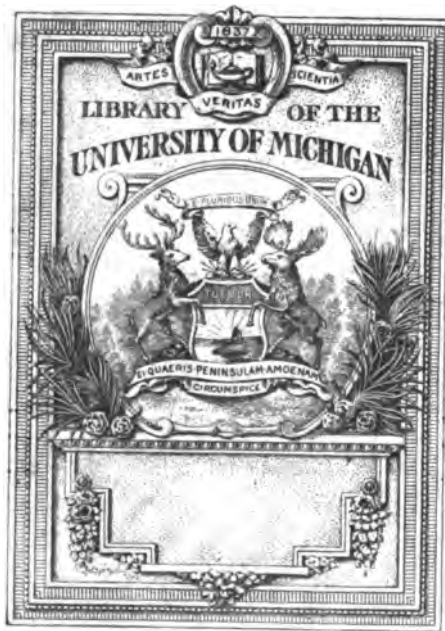
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IN THE PREPARATION OF GALENICALS

WITH AN ACCOUNT OF
PHARMACEUTICAL TESTING AND THE ASSAY OF CRUDE
AND MANUFACTURED DRUGS

TOGETHER WITH
A SHORT TREATISE ON THE ART OF DISPENSING

BY

E. W. LUCAS, F.I.C., F.C.S.

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AUTHOR OF 'THE BOOK OF PRESCRIPTIONS,' 'THE BOOK OF RECEIPTS'

WITH TWO HUNDRED AND TWENTY-FOUR ILLUSTRATIONS

SECOND EDITION



LONDON

J. & A. CHURCHILL

7 GREAT MARLBOROUGH STREET

1908

ILLUSTRATIONS

In a book of this description it would have been impracticable to prepare fresh illustrations of all the apparatus described. The author has therefore drawn largely upon his friends, and a list is appended of those who have kindly placed blocks, *many of them copyright*, at his disposal. To these the author expresses his best thanks.

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PREFACE

TO

THE SECOND EDITION

Since the first edition of this work was published ten years have elapsed, during which period considerable additions have been made to the stock of pharmaceutical knowledge. The author has, therefore, felt it desirable to publish a second edition. The book has been largely rewritten, and it is hoped that none of the more important advances in practical pharmacy have been overlooked. The chapters on Urine and Volumetric Analysis have been deleted, but in their place more detailed information regarding the manufacture of galenicals has been included. It is of course recognised that the retail pharmacist does not require the larger apparatus and machines herein described and figured; nevertheless, it is advisable that students and others should be acquainted with at least some of the more important methods by which pharmaceutical preparations are manufactured on a large scale.

The Pharmaceutical Press has been freely consulted, and due acknowledgment is hereby tendered to the authors of the papers from which abstracts have been made. In conclusion the author expresses his best thanks to his friends Mr. J. Stuart Hills and Mr. H. B. Stevens for help, as well as for assistance in proof-reading.

LONDON: *April* 1908.

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PART I

GENERAL PROCESSES AND DESCRIPTIONS OF APPARATUS

11

CHAPTER I

INTRODUCTION

Pharmacy (*pharmakon*, a drug) is the art of identifying, preparing, and dispensing medicinal substances.

A Pharmacopœia (*pharmakon*, a drug; and *poieo*, I make) is a dispensatory or book of directions, published by authority, which defines and fixes the standards of purity of materials used in medicine; it also describes the physical and chemical properties of these materials, means of identification, and, in many cases, methods of preparation.

In earlier times the Pharmacopœias of many countries were only published in Latin, but the tendency of later years has been to print the titles in Latin and the text in the vulgar tongue, as exemplified in the British Pharmacopœia. In this the arrangement is as follows:

1. The official Latin title.
2. The English title.
3. The official synonym (if any).
4. The formula, if a definite substance.
5. The description or definition.
6. The characters and tests.

WEIGHTS AND MEASURES¹

The imperial system of weights and measures is based on two units—the *yard*, the unit of length; and the *pound*, the unit of mass. These units, from which all others are derived, are deposited at the Standards Office, Westminster.

The *yard* is the straight line or distance between the centres of two gold plugs recessed in a bronze bar, measured at a temperature of 62° F. To avoid flexure and facilitate expansion and contraction due to variations of temperature, the bar is supported on bronze rollers. By the Weights and Measures Act this measure is declared to be the

¹ *Yard*, from the Anglo-Saxon *gyrd*, a rod.

Inch, from the Anglo-Saxon *ynce*, or the Latin *uncia*, a twelfth part.

Pound, from the Anglo-Saxon *pund*, or the Latin *pondus*, a weight.

Grain, from the Latin *granum*, a seed.

Quart, from the Latin *quartus*, a fourth.

Pint, from *picta*, painted on, or marked, as the ancient measuring vessels.

only unit or standard measure of extension, and all other measures of extension, whether linear, superficial, or solid, are derived from it.

One third part of the imperial standard yard is called a *foot*, and one twelfth part of the foot an *inch*.

The *pound* is the weight *in vacuo* of a platinum cylinder, and from this unit all other weights are derived. One sixteenth part of the imperial standard *pound* is called an *ounce*, and one sixteenth part of such an ounce a *dram*, and one seven-thousandth part of the imperial standard pound a *grain*. *These weights are called avoirdupois weights.*

The unit or standard measure of capacity is the imperial *gallon*; it contains ten imperial pounds weight of distilled water weighed in air against brass weights, the water and air both being at a temperature of 62° F., the barometer standing at 30 inches. The *quart* is the one-fourth part, and the *pint* the one-eighth part of the imperial standard gallon.

It is unlawful to use for trade purposes any weight or measure other than those derived from the imperial standards. The following exceptions are, however, made: Drugs, sold by retail (dispensed), being allowed to be vended by *apothecaries'* weight, and precious metals and precious stones by *troy* weight.

In 1897 a Bill legalising the use of *weights and measures of the metric system* came into operation, and standards derived from the *metre-international* and *kilogramme-international* were deposited with the Board of Trade. These standards, which assure the invariability and accuracy of metric weights and measures throughout the civilised world, were adopted by a committee of representatives from the twenty-one States belonging to the Convention.

The unit of length, the *metre-international*, is the length (measured at 0° C.) of an iridio-platinum bar deposited with the Board of Trade. The legal equivalent of the metre is 39·370113 inches.

The unit of weight, the *kilogramme-international*, is the weight *in vacuo* of an iridio-platinum cylinder deposited with the Board of Trade. The *litre* contains one kilogramme of distilled water at its maximum density (4° C.).

These standards are all arbitrary. Thus, the yard measure, if lost, is no longer required, as formerly, to be restored by reference to the length of a pendulum vibrating seconds of mean time in the latitude of Greenwich at sea level, nor the pound to be restored by computation from the weight of a cubic inch of distilled water at 62° F. Neither is the theoretical metre any longer regarded as the one ten-millionth part of the elliptic quadrant of the meridian passing through Paris, nor the kilogramme as the weight of distilled water contained in a cubic decimetre. The metre-international has, however, been found to contain 1,553,163·5 wave-lengths of the red ray of the spectrum of cadmium measured in air at 15° C., and under

an atmospheric pressure of 760 mm., so that the length could be re-determined, if necessary, to within a micron.

As it would obviously be undesirable that the original standards should be in every-day use for purposes of comparison, the Board of Trade provides exact copies of the imperial ones, as well as multiples and aliquot parts of the same.

Every weight and measure used in trade is required to have its denomination stamped upon it in legible figures and letters, in addition to a stamp of verification.

DENOMINATION OF STANDARD WEIGHTS AND MEASURES IN COMMON
USE IN PHARMACY UNDER THE DIRECTION OF THE BOARD OF
TRADE

Apothecaries' Weight

Weight in grains in terms of the imperial
standard pound, which contains
7000 such grains

OUNCES :

10 ounces	4800 grains
8 "	3840 "
6 "	2880 "
4 "	1920 "
2 "	960 "
1 ounce	480 "

Abbreviations or
Symbols allowed

DRACHMS :

4 drachms, or half an ounce	240 "	℥iv.
2 "	120 "	℥ij.
1 drachm	60 "	℥j.

SCRUPLES :

2 scruples	40 "	℥ij.
1½ " or half a drachm	30 "	℥ss.
1 scruple	20 "	℥j.
½ "	10 "	℥ss.

GRAINS :

6 grains	6 "
5 "	5 "
4 "	4 "
3 "	3 "
2 "	2 "
1 grain	1 grain
½ "	0·5 "

Apothecaries' Measure

Denomination	Temperature = 62° Fahrenheit. Barometer = 30 inches. Imperial pound = 7000 grains.
A fluid ounce and the multiples thereof from 1 to 40 fluid ounces .	One fluid ounce contains 437·5 grains weight, or $\frac{1}{160}$ of the imperial gallon
Half a fluid ounce	
A fluid drachm and the multiples thereof from 1 to 16 fluid drachms	One fluid drachm = $\frac{1}{8}$ fluid ounce, or 54·6875 grains of water
Half a fluid drachm	
A minim and the multiples thereof from 1 to 60 minims	One minim = $\frac{1}{80}$ fluid drachm, or 0·9114583 grain of water

Avoirdupois Weight

Denomination	Abbreviations or Symbols allowed
56 pounds, or half hundredweight	56 lb., or $\frac{1}{2}$ cwt.
28 „ or quarter hundredweight	28 „ or $\frac{1}{4}$ „
14 „ or stone	14 „
7 „	7 „
4 „	4 „
2 „	2 „
1 pound, or 7000 grains	1 lb.
8 ounces, or half pound	8 oz., or $\frac{1}{2}$ lb.
4 „ or quarter pound	4 „ or $\frac{1}{4}$ „
2 „	2 „
1 ounce, or 437·5 grains	1 „
8 drams, or half ounce	8 drs., or $\frac{1}{2}$ oz.
4 „	4 „ or $\frac{1}{4}$ „
2 „	2 „
1 dram	1 dr.
$\frac{1}{2}$ „	$\frac{1}{2}$ „

Grains Weight

Denomination	Abbreviations allowed
4000 grains.	4000 gr.
2000 „	2000 „
1000 „	1000 „
500 „	500 „
300 „	300 „
200 „	200 „
100 „	100 „
50 to 0·01 grain	50 to 0·01 gr.

Troy Weight

Decimal troy *bullion* weights are legal from 500 ounces troy down to 0·001 ounce troy, but these weights are not employed in pharmacy. Apothecaries' weights are often incorrectly termed troy weights.

Imperial Measure

Denomination	Abbreviations
1 gallon	1 gall. Cj. ¹
$\frac{1}{2}$ „	$\frac{1}{2}$ „ Css.
1 quart	1 qt. Oij.
1 pint	1 pt. Oj.
$\frac{1}{2}$ „	$\frac{1}{2}$ pt. Oss.
1 gill	$\frac{1}{4}$ pt.

A cubic inch of water at 62° F., free from air and weighed in air against brass weights of the density 8·143, with the barometer at 30 inches, weighs 252·286 grains.

A cubic foot of water, free from air, under precisely the same conditions, weighs 62·278601 lb.; that is to say, a cubic foot of water measures very nearly $6\frac{1}{4}$ gallons.

To convert pounds troy into pounds avoirdupois $\times 0\cdot822857$

„ „ avoirdupois into pounds troy $\times 1\cdot21528$

Metric Weights and Measures, with their Legal Equivalents

1 micromillimetre ($\mu\mu$) ($\frac{1}{1000000}$ milli-	
metre	= 0·0000003937 inch
1 micron (μ) ($\frac{1}{1000}$ millimetre)	= 0·0003937 inch
1 millimetre (mm.) ($\frac{1}{1000}$ metre), 0·001	= 0·03937 inch
1 centimetre ($\frac{1}{100}$ metre), 0·01	= 0·3937 „
1 decimetre ($\frac{1}{10}$ metre), 0·1	= 3·937 inches
1 metre, 1·0	= 39·370113 „
1 cubic centimetre (c.c.)	= 16·9315 minims
1 litre (or 1000 cubic centimetres)	= 1·7598 pints
1 milligramme (mgr.), 0·001	= 0·01543235639 grain
1 centigramme ($\frac{1}{100}$ gramme), 0·01	= 0·1543235639 „
1 decigramme ($\frac{1}{10}$ gramme), 0·1	= 1·543235639 grains
1 gramme, 1·0	= 15·43235639 „
1 kilogramme	= 15432·35639 grains
1 inch	= 25·39997 millimetres
1 foot (12 inches)	= 0·30479967 metre
1 yard (3 feet)	= 0·914399 „
1 minim (m) (0·91146 grain)	= 0·05919 cubic centimetre
1 fluid drachm (ʒ)	= 3·552 cubic centimetres
1 fluid ounce (ʒ)	= 28·4123 „ „
1 gallon (Cong.)	= 4·5459631 litres
1 grain	= 0·064798918 gramme
1 ounce, avoirdupois (437·5 grains)	= 28·34953 grammes
1 pound (7000 grains)	= 0·45359243 kilogramme
1 hundredweight (cwt.)	= 50·80235216 kilogrammes

¹ The sign for the gallon, C, is derived from the Latin *congius*, a Roman measure containing six sextarii. The sign for the pint, O, is derived from *octarius*. The Roman sextarius was the sixth part of the congius, but as our gallon is divided into eight parts, it became necessary to coin a fresh word.

1 grain, apothecaries' weight	=	64.798918 milligrammes
1 scruple, " " (20 grains)	=	1.2959783 grammes
1 drachm, " " (60 grains)	=	3.887935 "
1 ounce, " " (480 grains)	=	31.1034806 grammes

The following are *approximate equivalents*, and may be used for rough calculations :

Length	Weight
1 millimetre (0.001) = $\frac{1}{25}$ inch approx.	1 gramme = $15\frac{1}{2}$ grains approx.
1 centimetre (0.01) = $\frac{1}{2}$ " "	1 kilogramme = 2 $\frac{1}{2}$ pounds "
1 decimetre (0.1) = 4 inches "	
1 metre = 3.28 feet "	

Capacity
1 cubic centimetre = 15 minims approx.
1 litre = { $1\frac{1}{4}$ pints "
{ or 61 cubic inches approx.

Maximum Error Tolerated in Weights (Order in Council, 1907)

Avoirdupois Weight	Allowance in Grains; heavy, or in excess only	
	Iron Weights	Brass Weights
56 lb.	100 grains	50 grains
28 "	40 "	20 "
14 "	24 "	12 "
7 "	16 "	8 "
4 "	12 "	6 "
2 "	8 "	4 "
1 "	4 "	2 "
8 oz.	4 "	2 "
4 "	4 "	2 "
2 "	1 grain	$\frac{1}{2}$ grain
1 " and under	$\frac{1}{2}$ "	$\frac{1}{4}$ "

Apothecaries' Weight	Allowance in Grains; heavy, or in excess only
10 ounces	0.3 grain
8 "	
6 "	
4 "	
2 "	0.2 "
1 ounce	
4 drachms	0.1 "
2 "	
1 drachm	0.08 "
2 scruples	
$1\frac{1}{2}$ "	
1 scruple	
$\frac{1}{2}$ "	0.08 "
6 grains	

Apothecaries' Weight	Allowance in Grains; heavy, or in excess only
5 grains	} 0.06 grain
4 „	
3 „	
2 „	
1 grain	} 0.05 „
$\frac{1}{2}$ „	
	0.04 „

Maximum Error Tolerated in Apothecaries' Graduated Glass Measures

Approximate Internal Diameter of Measure	Allowance in Minims, in excess or in deficiency
4 inches	25 minims
$3\frac{1}{2}$ „	20 „
3 „	18 „
$2\frac{1}{2}$ „	14 „
2 „	10 „
$1\frac{3}{4}$ „	8 „
$1\frac{1}{2}$ „	6 „
$1\frac{1}{4}$ „	5 „
1 inch	4 „
$\frac{7}{8}$ „	3 „
$\frac{3}{4}$ „	2 „
$\frac{5}{8}$ „	1 minim
$\frac{1}{2}$ „	$\frac{1}{2}$ „

Maximum Error Tolerated in Larger Measures of Capacity

	Allowance in excess only
Gallon	2 fluid ounces
Half gallon	1 fluid ounce
Quart	1 „ „
Pint	4 fluid drachms
Half pint	3 „ „
Gill	2 „ „

NOTE.—Although weights and measures falling within these limits are stamped, pharmacists should see that dispensing weights are accurate.

CHAPTER II

WEIGHING AND MEASURING

The balance.—The balance is an instrument for determining the relative weight of bodies ; in other words, the measure of their gravitating force.

The ordinary prescription balance (fig. 1) consists of a lever of the first kind, with its fulcrum in the middle. This lever is called the beam. At the extremities of the beam are suspended two pans.

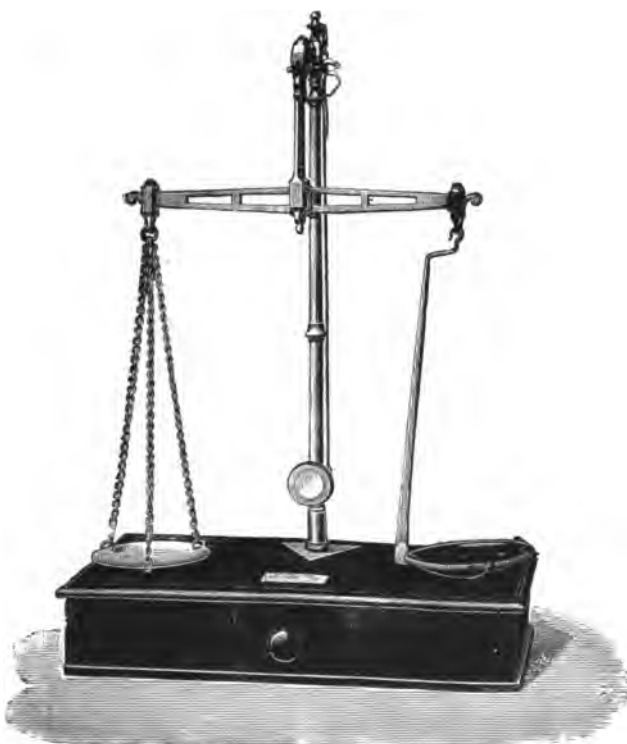


FIG. 1.—DISPENSING BALANCE

The fulcrum consists of a hardened steel prism, called the *knife-edge*, which passes through the beam at right angles, and rests with its sharp edge or axis of suspension upon two supports made of hardened steel.

Since two equal forces in a lever of the first kind cannot be in equilibrium unless their leverages are equal, the length of the arms ought to remain equal during the process of weighing. To secure this the pans are suspended from hooks, each of which is dependent on a knife-edge enclosed in the box ends of the beam. By this means the pans are suspended from mere points, which are practically unmoved during the oscillations of the beam.

When a good balance is placed on a level plane it ought to satisfy the following conditions :

1. *The two arms of the balance ought to be equal ; otherwise, unequal weights will be required to produce equilibrium. To test whether the arms of the balance are actually equal, weights are placed in both pans until the beam becomes horizontal : the contents of the pans are then interchanged, when, if the arms are equal, the beam will remain horizontal ; but if not, it will descend on the side of the longer arm.*

2. *The balance ought to be in equilibrium when the pans are empty, for otherwise unequal weights must be placed in the pans to produce equilibrium. It must be borne in mind, however, that the arms are not necessarily equal even if the beam remains horizontal when the pans are empty, for this result might be brought about by giving the longer arm the lighter pan.*

3. *The beam being horizontal, its centre of gravity ought to be in the same vertical line with the edge of the fulcrum, and a little below the latter, otherwise the beam will not be in stable equilibrium. Further, the beam should be perfectly rigid, of moderate length, and as light as is consistent with strength.*

In many dispensing establishments the *hand balance* (fig. 2) is preferred for general use. Its advantage depends upon the rapidity with which weighings may be made, as well as the fact that, owing

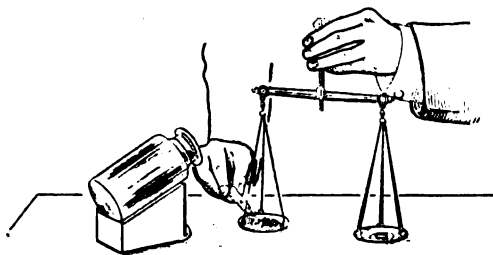


FIG. 2.—HAND BALANCE.

to its portable form, such a balance may be carried from one place to another for the purpose of making a weighing, instead of bringing all substances to the balance. The hand balance should be made of the best materials, the beam about 7 inches long. The knife-edges and rings at the ends of the beam should be contained in boxes to

protect them from injury. Dispensing balances of this kind are usually provided with nickel-plated pans. The greater number of medicinal substances may be weighed directly on these pans without injury, but such chemicals as iodine, phosphorus, mercuric chloride, etc., should be weighed on glass. For this purpose it is convenient to keep a pair of accurately balanced watch-glasses of such size as will lie comfortably on the metal pans.

Some pharmacists prefer balances having one of the pans made of glass. The objection to the latter is its liability to chip when tapped upon the edges of mortars and glasses, necessitating frequent adjustment. If money is no great object, the pans may be made of platinum, as this metal is attacked by very few chemicals in the cold.

The manner of holding the balance is shown in fig. 2, the tassel being grasped between the thumb and forefinger of the left hand, the other fingers resting against the frame to ensure steadiness. Hand balances should only be raised a short distance from the counter, and on no account should the practice of raising the balance to the level of the eye be encouraged.

For weighing quantities of less than 2 grains a more sensitive balance than either of the foregoing is necessary. Fig. 3 shows a very sensitive type of balance constructed on the Dutch system.

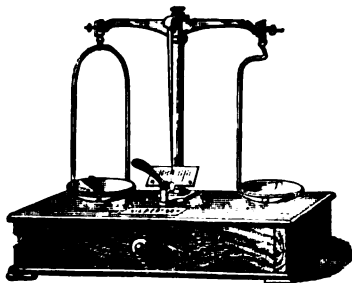


FIG. 3.—POISON BALANCE.



FIG. 4.—COUNTER BALANCE.

The bearings are of hardened steel working on agate planes, and the instrument is provided with a steel pointer and index. Such a balance should weigh to the tenth of a grain.

For weighing large quantities of material, balances of stronger construction are required. The forms in most common use are known as 'inverted' or counter machines, and possess more than three bearings. When the load does not exceed 1 to 2 lb. the pattern shown in fig. 4 finds many applications, while fig. 5 is designed for loads up to 28 lb.

Stamping of trade balances.—Every weighing instrument used in trade is required to have the manufacturer's name as well as the maximum load marked in some conspicuous place. The maximum

load indicates the greatest weight the machine is constructed to carry. In addition, every instrument is required to bear an

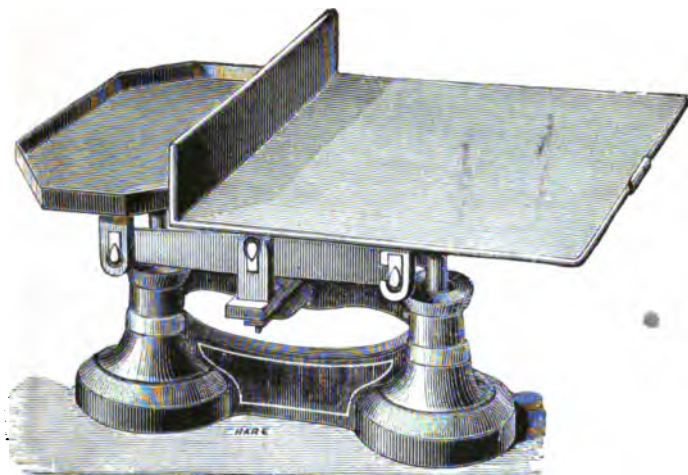


FIG. 5.—LARGE COUNTER BALANCE.

inspector's stamp of verification, which is usually placed on a small stud or plug of soft metal under or above the central bearing.

All scale beams and counter weighing machines for weighing under 1 cwt. are required to turn accurately within the following limits :

Maximum Load of the Weighing Instrument	Scale Beam Balances	Counter Weighing Machines with more than three bearings, and Spring Balances
1 cwt.	4 drams avoird.	8 drams avoird.
56 lb.	2 " "	4 " "
14 "	1 dram "	2 " "
7 "	20 grains	1 dram "
4 "	5 "	20 grains
1 "	2 "	10 "
1 oz.	1 grain	5 "

The above table only gives the limit of sensibility required in machines for purposes of vending. Prescription balances, whether of the hand or standard pattern, should turn readily with $\frac{1}{2}$ grain, while the poison balance should be sensitive to $\frac{1}{10}$ grain.

The chemical balance.—For general pharmaceutical assaying the balance shown in fig. 3 is sufficiently exact, but for operations requiring a higher degree of accuracy a proper chemical balance must be employed. Fig. 6 illustrates a quick-moving balance, constructed on Bunge's system. The triangular beam, which is very short, is made out of one piece of metal, thus ensuring rigidity ; all the knife-edges and planes are made in agate, friction being reduced

to a minimum. The pans are platinised to prevent rust, and are provided with compensating stirrup suspenders to support them, thus preventing shifting of the knife-edges when the load is not placed in the centre of the pans. The centre agate plane in this class of



FIG. 6.—ANALYTICAL BALANCE.

balance, unlike all others, is made to rise perpendicularly and lift the beam, so that the latter swings quite free from its supports. A balance in good order should be sensitive to $\frac{1}{10}$ milligramme (0.0001) with a load of 100 grammes.

Balances should be kept free from acid fumes and moisture. A bottle containing quicklime or dried calcium chloride ought to be kept in the balance case, and replenished as often as required. When working, the motion of the beam should be gently arrested when the pointer is at zero, and on no account should anything be added to or removed from the pans while the beam is free to oscillate. Substances to be weighed should not be placed directly on the pans; liquids and hygroscopic solids are weighed in stoppered glass bottles; solids unaffected by exposure to the atmosphere may be weighed in platinum or porcelain dishes, or in watch-glasses. Fig. 7 shows the weighing bottle in general use; fig. 8, a weighing tube; and fig. 9, a pair of watch-glasses held together by a spring clip.

The weights used in analytical operations are those of the metric system. The usual shape for weights of 1 gramme and upwards

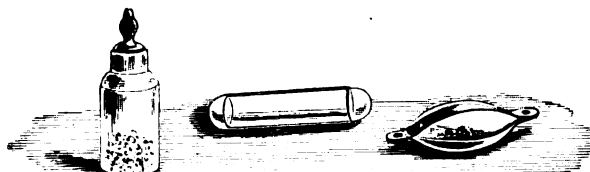


FIG. 7. WEIGHING BOTTLE. FIG. 8. WEIGHING TUBE. FIG. 9. WATCH-GLASSES.

is that of a short cylinder, with a handle at the top, which enables them to be lifted by small forceps. The weights from 0.5 gramme downwards are made of either platinum or aluminium. These small weights are usually flattened, with one corner turned up to facilitate lifting. Fig. 10 shows such a set of analytical weights, contained in a velvet-lined box, and provided with forceps for lifting them.



FIG. 10.—ANALYTICAL WEIGHTS.

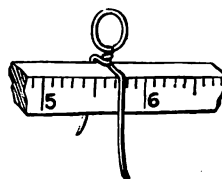


FIG. 11.—RIDER.

50	20	20	10
5	2	2	1
.5	.2	.2	.1
.05	.02	.02	.01

FIG. 12.

The *rider* is a piece of wire bent into the form shown in fig. 11, so that it lies astride the graduated beam. As a rule, balances employed in chemical analysis have each arm of the beam divided into ten equal divisions, each of which is subdivided into ten. Using a *centigramme* (0.01) *rider*, each division on the beam corresponds to 1 milligramme (0.001), and each of the subdivisions to the tenth of a milligramme (0.0001).

It is convenient to keep the weights on a sheet of white cardboard, ruled into as many squares as there are weights, each square having its denomination plainly marked in ink (fig. 12). When a weighing has

been made, a check is obtained by comparing the value of the weights on the scale pan with the uncovered spaces left on the card. This card of weights should be kept on the floor of the balance-case, on the right-hand side of the pedestal.

Measures.—All measures and graduates used in trade are required to bear a stamp of verification. For measuring large volumes of liquids which are without action on the metal, copper vessels, tinned



FIG. 13.—COPPER MEASURE.



FIG. 14. PEWTER MEASURE.

inside, are usually employed, as fig. 13. In measures of this description the proper volume is indicated *when the surface of the liquid corresponds with the constricted portion of the neck*. Measures of the type illustrated in fig. 14 contain the designated volume *when filled to the brim*. For measuring hot liquids the graduated earthenware



FIG. 15.—GRADUATED JUG.

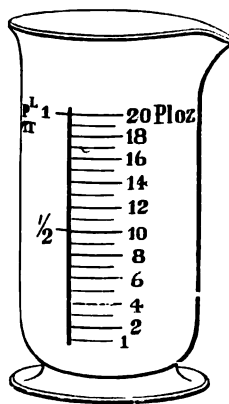


FIG. 16.—GLASS GRADUATE.

jug shown in fig. 15 is exceedingly useful. The foregoing class of measures cannot be used for dispensing purposes on account of the comparatively large errors tolerated. Thus, a one-gallon metal measure may hold two fluid ounces in excess and yet be a legal measure; the

half-gallon and quart may hold one fluid ounce, and the pint half an ounce, in excess. As will be seen from the table given in the preceding chapter, apothecaries' measures are required to be more exact.

For dispensing purposes glass measuring vessels are employed. For quantities from forty to ten fluid ounces the graduates may be of the shape shown in fig. 16, but for smaller quantities the measures should be conical (figs. 17 and 18). It is not well to have the graduations too close together in any measure, as this leads to confusion. Thus 40 fl. oz. and 20 fl. oz. graduates cannot accurately be used to measure smaller fractions than one fluid ounce, nor 10 fl. oz.

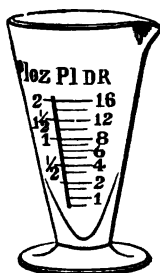


FIG. 17.—CONICAL GRADUATE.



FIG. 18.—CONICAL GRADUATE.

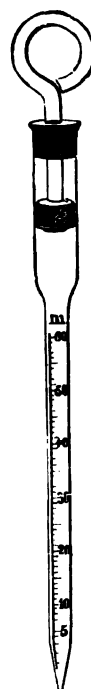


FIG. 19.—MINIM PIPETTE.

measures to indicate less quantities than half an ounce. The following graduates are a necessary equipment of the dispensing counter: 40 fl. oz., 10 fl. oz., 16 fl. dr., and 4 fl. dr. For measuring small quantities of potent remedies, as prussic acid, solution of strychnine, etc., a minim pipette should be used. This consists of a pipette graduated in minims fitted with a plunger like an ordinary syringe (fig. 19).

When measuring with glass graduates, the bottom of the meniscus should be made to coincide with the graduation. At first considerable difficulty may be experienced in holding the measure level, and, until this habit is acquired, the student should check every measurement by placing the glass on a level surface.

CHAPTER III

SPECIFIC GRAVITY

An intimate acquaintance with the methods used for ascertaining the specific gravities of solids and liquids is of importance to the pharmacist.

Specific gravity may be defined as the *relative weights of equal volumes* of substances expressed in terms of a given unit; in the case of gases the unit is hydrogen, while liquids and solids are compared with distilled water at 60° F. (15·5° C.).

In order to determine the specific gravity of a substance it is necessary to find its weight and the weight of an equal volume of the unit, and then to divide the first weight by the second; the quotient expresses the specific gravity of the substance.

The specific gravity of a liquid may be determined in three ways: (1) by hydrometer; (2) by direct weighing in a flask; (3) by the hydrostatic balance.

(1) *By hydrometer* (fig. 20).—Float the hydrometer in the liquid adjusted to 15·5° C., and read off the number indicated at the surface of the liquid. The specific gravity is obtained by dividing this number by 1000.

Examples.—An ordinary hydrometer floats in sulphuric acid at 1843: what is the specific gravity?

$$1843 \div 1000 = 1.843 \text{ sp. gr.}$$

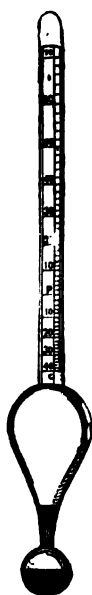


FIG. 20.
HYDROMETER

An ordinary hydrometer floats in ether at 720: what is the specific gravity? $720 \div 1000 = 0.720 \text{ sp. gr.}$

For liquids heavier than water hydrometers are graduated from 1000 upwards; for liquids lighter than water from 1000 downwards.

Specific gravity beads are frequently employed by manufacturers who require constantly to adjust the specific gravity of the same class of liquid. These beads do not rise to the surface, but float indifferently in any liquid of their own gravity, and are especially useful as indicators when a liquid has to be evaporated to a given density. They may be regarded as hydrometers which indicate but one gravity.

(2) *By the specific gravity flask.*—As a rule, flasks holding 50 or 25 grammes of water at 15.5°C . are employed. The operation simply consists in counterbalancing the flask, filling it with the liquid at 15.5°C ., and weighing. The weight of the liquid divided by the capacity of the flask gives the specific gravity.

Example.—A 50-c.c. flask weighed 15 grammes; when filled with water, 65 grammes; filled with rectified spirit, 56.7 grammes: what is the specific gravity of the spirit? $56.7 - 15 = 41.7$; and $41.7 \div 50 = 0.834$.

The bottle shown in fig. 21 is commonly used for taking specific gravities, but is not to be generally recommended.¹ It is of slight blown glass, fitted with a perforated stopper. The bottle is filled, the stopper inserted, when the surplus liquid finds its way out through the perforation. The bottles may be used when the temperature is

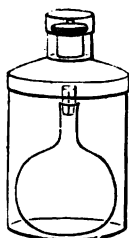


FIG. 21.—SPECIFIC GRAVITY BOTTLE AND COUNTERPOISE IN CASE.



FIG. 22.—REGNAULT'S SPECIFIC GRAVITY BOTTLE.

below 15.5°C .; but it is manifest that if the bottle is filled at 15.5°C ., and the room in which the operation of weighing is conducted is 18°C ., expansion of the liquid will take place, and the experiment will be ruined by reason of the contents oozing out through the perforated stopper.

Fig. 22 shows the specific gravity bottle designed by Regnault. The liquid is introduced in the ordinary way, the temperature adjusted to 15.5°C ., the bottom of the meniscus being made to correspond with a mark on the neck. The stopper is then inserted, and the bottle weighed. The advantages of a bottle of this description are obvious, as, once it is filled to the mark with liquid at the proper temperature, the weighing may be conducted at any higher temperature, the neck of the bottle being sufficiently long to allow for expansion within any reasonable limits without loss. Moreover, as the stopper is accurately ground, there can be no loss by evaporation.

(3) *By the Westphal balance.*—The apparatus known as the Westphal specific gravity balance (fig. 23) depends upon the application of the principle that a solid body immersed in a liquid apparently loses exactly the weight of its own volume of that liquid. A small thermometer, counterbalanced by the sliding weight at the opposite

¹ It is, however, useful in taking the specific gravities of fats, *q.v.*

end of the beam, is placed in the liquid, and the loss of weight restored by rider weights, which indicate the specific gravity without further

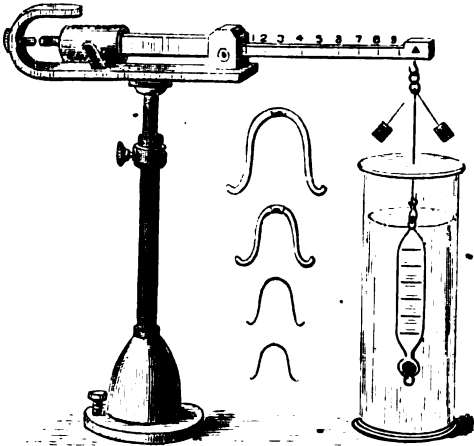


FIG. 23.—WESTPHAL SPECIFIC GRAVITY BALANCE.

calculations. Fig. 24 illustrates the position of the weights for a few specific gravities.

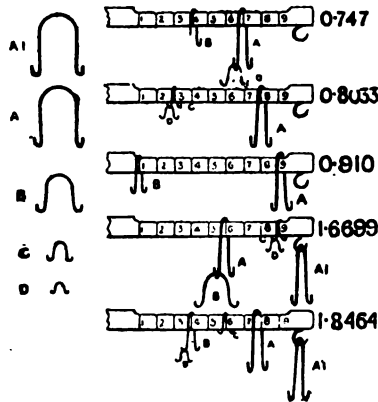


FIG. 24.

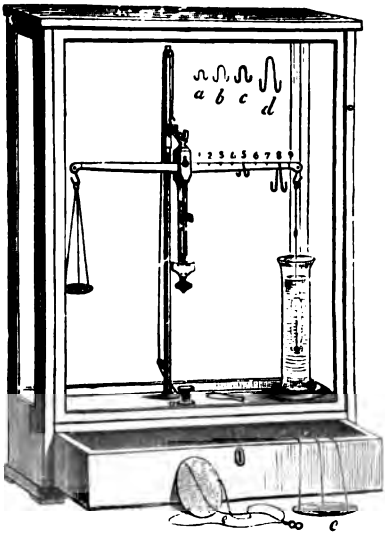


FIG. 25.—MOHR'S BALANCE.

Fig. 25 illustrates Mohr's method. Any accurate balance may be used by detaching one of the scale pans and suspending a thermometer in its place, and then counterpoising. The further operation does not differ from that described above.

If a specific gravity bottle or instrument graduated at any fixed temperature be used for a liquid at a higher or lower temperature,

the specific gravity of that liquid as referred to water can only be ascertained by determining the weight of an equal volume of water also at the same temperature. This may be done by actual experiment or by reference to the following table :

Weight of 1 c.c. of Distilled Water at Different Temperatures

C.	Gramme	C.	Gramme
At 0° =	0.99988	At 14° =	0.99930
1° =	0.99993	15° =	0.99915
2° =	0.99997	15.5° =	0.99908
3° =	0.99999	16° =	0.99900
4° =	1.00000	17° =	0.99884
5° =	0.99999	18° =	0.99866
6° =	0.99997	19° =	0.99848
7° =	0.99993	20° =	0.99827
8° =	0.99989	21° =	0.99806
9° =	0.99982	22° =	0.99785
10° =	0.99974	23° =	0.99762
11° =	0.99965	24° =	0.99738
12° =	0.99955	25° =	0.99714
13° =	0.99943		

Thus a 50-gramme specific gravity bottle graduated at 15.5° C. is found to hold 53 grammes of a liquid at 18° C.

Reference to the above table shows that 1 gramme of distilled water at 18° C. weighs 0.99866 gramme.

Therefore, at 15.5° C. the specific gravity of the liquid will be

$$\frac{53}{50 \times 0.99866} = 1.0614.$$

Specific Gravity of Solids

(a) When the substance is heavier than and insoluble in water.

The substance is suspended by fine silk to one arm of a balance and weighed in air; it is then weighed in distilled water, as fig. 26. According to the Law of Archimedes it displaces its own *volume* of water, and the weight in air divided by the *weight of the displaced water* gives the specific gravity.

Example.—A piece of metal weighs 12.04 grammes in air, and when suspended in distilled water at 15.5° C. 10.47 grammes : what is its specific gravity? $12.04 - 10.47 = 1.57$. Then $12.04 \div 1.57 = 7.6688$ sp. gr.

(b) When the substance is insoluble in but lighter than water, it is necessary to attach a sinker to the body to keep it entirely immersed during weighing. The procedure is as follows.

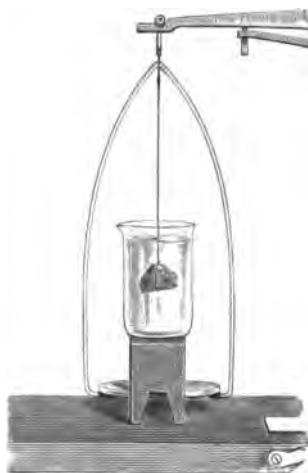


FIG. 26.

(1) Weigh the sinker in air, then in water, and subtract the latter from the former weight. *This gives the weight of water displaced by the sinker.*

(2) Weigh the substance in air, then fasten it with fine silk to the sinker; weigh both in water and subtract from their combined weight in air. *This gives the weight of water displaced by both.*

(3) If now the weight of water displaced by the sinker alone (1) is subtracted from the weight of water displaced by sinker and substance together (2), *the difference is the weight of water displaced by the substance alone.*

(4) The specific gravity can now be obtained by dividing the weight of the substance in air by the weight of water it displaces.

Example.—A piece of yellow beeswax is found to weigh 3 grammes in air; the sinker used weighs 12 grammes in air and 10·8 grammes in water at 15·5° C.; their combined weight in water is 10·68 grammes: what is the specific gravity of the wax?

1. Weight of sinker in air	12·00
Weight of sinker in water	10·80
	<hr/>
Weight of water displaced by sinker	1·20
	<hr/>
2. Weight of sinker in air	12·00
Weight of wax in air	3·00
	<hr/>
	15·00
Combined weight in water	10·68
	<hr/>
Weight of water displaced by both	4·32
3. Weight of water displaced by sinker alone	1·20
	<hr/>
Weight of water displaced by wax alone	3·12

The weight of the wax in air is 3 grammes; the weight of an equal bulk of water 3·12 grammes. Then $3\cdot00 \div 3\cdot12 = 0\cdot9615$, the specific gravity of the wax.

(c) For the determination of the specific gravity of solids soluble in water some other liquid of known specific gravity must be used for immersion. The substance is weighed in air, then in the liquid; the weight in air is divided by the weight of the liquid displaced, and the quotient multiplied by the specific gravity of that liquid. One of the most convenient liquids to use for the above purpose is rectified oil of turpentine, which has a specific gravity of about 0·870.

Example.—A crystal weighs 35 grammes in air, and 15·95 grammes when immersed in oil of turpentine (sp. gr. 0·87): what is its specific gravity?

Weight of crystal in air	35·00
Weight of crystal in turpentine	15·95
	<hr/>
Weight of turpentine displaced	19·05

Then $35.00 \div 19.05 = 1.83$, specific gravity of crystal as compared with oil of turpentine. Then $1.83 \times 0.87 = 1.5984$, specific gravity of crystal as compared with water.

Baumé's and Twaddell's hydrometers are commonly employed in manufacturing operations on a large scale, and as it is sometimes necessary to convert degrees according to these scales into specific gravities, or *vice versa*, the following rules are given :

To convert degrees Baumé to specific gravity

(a) For liquids lighter than water :
$$\frac{144}{\text{Baumé}^\circ + 134}$$

Example.—Find the specific gravity corresponding to 20° B.

$$\frac{144}{20 + 134} = 0.935 \text{ sp. gr.}$$

(b) For liquids heavier than water :
$$\frac{144}{144 - \text{Baumé}^\circ}$$

Example.—Find the specific gravity corresponding to 10° B.

$$\frac{144}{144 - 10} = 1.075 \text{ sp. gr.}$$

To convert specific gravity to degrees Baumé

(a) For liquids lighter than water :
$$\frac{144}{\text{sp. gr.}} - 134^\circ.$$

(b) For liquids heavier than water :
$$144 - \frac{144}{\text{sp. gr.}}$$

To convert degrees Twaddell to specific gravity

$$\text{Twaddell}^\circ \times 0.005 + 1.000.$$

Example.—Find the specific gravity corresponding to 80° Tw.

$$80 \times 0.005 = 0.400. \text{ Then } 0.400 + 1.000 = 1.400 \text{ sp. gr.}$$

To convert specific gravity to degrees Twaddell

$$\text{Sp. gr.} - 1.000 \div 0.005.$$

Example.—Find the number of degrees Twaddell corresponding to specific gravity 1.400.

$$1.400 - 1.000 = 0.400. \text{ Then } \frac{0.400}{0.005} = 80^\circ \text{ Tw.}$$

Table showing the relation of Degrees of Baumé's Hydrometer
to Specific Gravities

Degrees Baumé	Specific Gravity	Degrees Baumé	Specific Gravity	Degrees Baumé	Specific Gravity	Degrees Baumé	Specific Gravity
For Liquids Heavier than Water							
0	1.0000	19	1.1507	38	1.3551	57	1.6477
1	1.0069	20	1.1600	39	1.3679	58	1.6666
2	1.0139	21	1.1693	40	1.3809	59	1.6860
3	1.0211	22	1.1788	41	1.3942	60	1.7058
4	1.0283	23	1.1885	42	1.4077	61	1.7261
5	1.0357	24	1.1983	43	1.4215	62	1.7469
6	1.0431	25	1.2083	44	1.4356	63	1.7682
7	1.0507	26	1.2184	45	1.4500	64	1.7901
8	1.0583	27	1.2288	46	1.4646	65	1.8125
9	1.0661	28	1.2393	47	1.4795	66	1.8354
10	1.0740	29	1.2500	48	1.4949	67	1.8589
11	1.0820	30	1.2608	49	1.5104	68	1.8831
12	1.0902	31	1.2719	50	1.5263	69	1.9079
13	1.0984	32	1.2831	51	1.5425	70	1.9333
14	1.1068	33	1.2946	52	1.5591	71	1.9595
15	1.1153	34	1.3063	53	1.5760	72	1.9863
16	1.1240	35	1.3181	54	1.5934	73	2.0139
17	1.1328	36	1.3302	55	1.6111	74	2.0422
18	1.1417	37	1.3425	56	1.6292	75	2.0714
For Liquids Lighter than Water							
10	1.0000	27	0.8917	43	0.8092	59	0.7407
11	0.9929	28	0.8860	44	0.8045	60	0.7368
12	0.9859	29	0.8805	45	0.8000	61	0.7329
13	0.9790	30	0.8750	46	0.7954	62	0.7290
14	0.9722	31	0.8695	47	0.7909	63	0.7253
15	0.9655	32	0.8641	48	0.7865	64	0.7216
16	0.9589	33	0.8588	49	0.7821	65	0.7179
17	0.9523	34	0.8536	50	0.7777	66	0.7142
18	0.9459	35	0.8484	51	0.7734	67	0.7106
19	0.9395	36	0.8433	52	0.7692	68	0.7070
20	0.9333	37	0.8383	53	0.7650	69	0.7035
21	0.9271	38	0.8333	54	0.7608	70	0.7000
22	0.9210	39	0.8284	55	0.7567	71	0.6965
23	0.9150	40	0.8235	56	0.7526	72	0.6930
24	0.9090	41	0.8187	57	0.7486	73	0.6896
25	0.9032	42	0.8139	58	0.7446	74	0.6863
26	0.8974						

CHAPTER IV

MELTING-POINT AND BOILING-POINT

The accurate determination of the melting-point of a body is frequently an important factor in estimating its purity. If a substance *begins* to melt at a certain temperature, but does not *completely* liquefy at the same temperature, the probability is that it contains some impurity. Various methods have been devised for determining the melting-points of substances, and, notwithstanding the apparent simplicity of the operation, even when working with the same material, the results of different workers are not always concordant.

The official process is as follows: A minute fragment of the substance to be examined is placed in a thin-walled tube having an internal diameter of about 1 millimetre ($\frac{1}{32}$ inch), and sealed at the lower end. This tube should be attached to a thermometer (a, fig. 27)

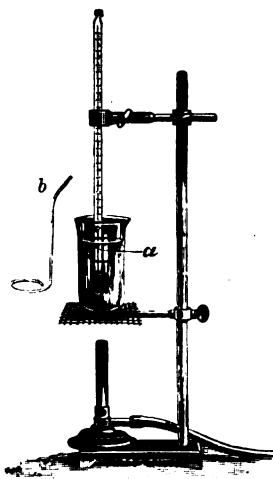


FIG. 27.—APPARATUS ARRANGED FOR TAKING THE MELTING-POINT OF A WAX.



FIG. 28.—ENLARGED VIEW OF CAPILLARY TUBE AND THERMOMETER BULB.

so that the substance is near the middle of the bulb, and the thermometer, with the attached tube, immersed in a liquid contained in a beaker placed over a small lamp flame. Water may be used for substances melting below $100^{\circ}\text{C}.$; sulphuric acid, glycerin, or liquid

paraffin for higher temperatures. The liquid should, by means of a glass ring (*b*), be constantly kept in motion until the substance is seen to melt. The temperature is noted, the tube cooled till the substance solidifies, and the operation repeated. *The latter reading of the thermometer should be taken as the melting-point.* To obtain accurate results the whole of the mercury column of the thermometer should be immersed in the heated liquid, but, as this is seldom practicable, the mean temperature of the emergent column—that is, of that portion above the surface of the heated liquid—should be ascertained, and the necessary correction applied. To obtain the mean temperature of the emergent column, a small thermometer is fixed in such a position that its bulb is about the middle of the emergent column. The correction may be calculated with approximate accuracy from the formula—

$$T = t + 0.000143 (t - t') N,$$

in which—

t = observed (*i.e.*, uncorrected) temperature.

t' = mean temperature of the emergent column.

N = length of the emergent column in scale degrees.

To ensure concordant results the capillary tube must be very closely watched, and the temperature noted the instant liquefaction takes place. It is better to make three or four determinations, and take the mean as the true melting-point.

BOILING-POINT

A liquid is said to boil when the tension of its vapour overcomes the pressure of the surrounding atmosphere.¹ All pure substances which boil without decomposition have a definite boiling-point if the pressure remains constant. An apparatus arranged for the determination of a boiling-point is shown at fig. 29. The thermometer should extend well below the side tube, but should

¹ The point at which the tension of the vapour of a liquid overcomes the pressure of the surrounding atmosphere is made clear by the following experiment: Procure a piece of glass tubing about 34 inches long, and seal one end in a Bunsen flame. Entirely fill with mercury and invert it over a small dish, when the mercury will fall until the weight of the column left is equivalent to that of the atmospheric pressure. If now by means of a piece of bent glass tubing a little water is introduced into the lower end of the tube, it at once rises to the surface of the mercury and begins to vaporise, the evident result of which will be the depression of the mercurial column. This depression of the mercury represents the tension of the vapour of water for the particular temperature at which the experiment is made. If now the mercury tube is surrounded by a second tube of wider bore, and steam blown freely through, the mercury will become more and more depressed until, when the temperature of the steam reaches 100° C., the level will correspond with that of the mercury in the dish. At this point the tension of the vapour within the tube will equal the atmospheric pressure.

not touch the surface of the liquid, as dissolved impurities, while altering the boiling-point of the liquid, do not affect the vapour. In accurate determinations the *entire length* of the mercurial column should be surrounded by the vapour, but for ordinary observations the thermometer may project some distance if protected from currents of hot air by a disc of cardboard resting on the cork of the flask. The liquid is introduced into the flask until about one-third full, a few pieces of recently ignited pumice added to prevent 'bumping,' and the side tube connected with a condenser.

On the application of heat the mercury in the thermometer rises until the liquid is in free ebullition, when it remains stationary. If the atmospheric pressure be normal this temperature is noted as the boiling-point, otherwise correction must be made.

If any considerable length of the mercurial column is not surrounded by the vapour, the temperature of the emergent column should be ascertained as directed under Melting-point, and the necessary correction applied.

Fractional distillation.—If the liquid is a mixture of bodies of different boiling-points, it will begin to boil at a temperature near to the boiling-point of its most volatile constituent. If the heat is carefully managed, distillation will proceed at this temperature until ebullition ceases, when the receiver is changed. If the heat is now increased, ebullition will recommence, and a more or less complete separation of the constituents be effected, provided the receivers are changed at intervals, so that the several fractions are collected between certain limits of temperature.

The boiling-point of a substance is one of its most important physical constants, and is in some cases almost the only means of readily identifying it.

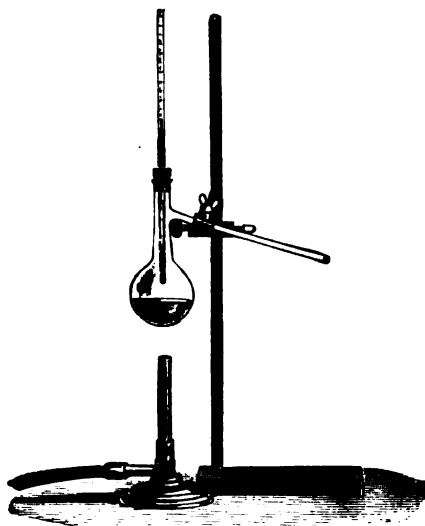


FIG. 29.—APPARATUS ARRANGED FOR DETERMINATION OF BOILING-POINT.

CHAPTER V

APPLICATIONS OF HEAT

Heat is not a substance, but a form of energy. All substances are supposed to consist of molecules in a state of vibration. The heat contained by a body is equivalent to the sum of the kinetic energies of its constituent molecules. The more rapid the vibration of these molecules, the greater the kinetic energy. The essential difference, then, between a hot and a cold body lies in the fact that in the former condition the molecules are in a more violent state of agitation than in the latter.

The effects of heat, therefore, are to cause bodies to expand, and to bring about a change of state, converting solids into liquids and liquids into gases.

Measurement of heat.—Instruments for comparing the sensible heat of various bodies are termed *thermometers*. The liquid used in their construction may be either mercury or alcohol; the former because it only boils at a very high temperature ($357^{\circ}\text{C}.$), the latter because it does not solidify above $-130^{\circ}\text{C}.$ The mercurial thermometer, which is almost exclusively used in pharmacy, consists of a calibrated glass tube of capillary bore, one end of which is blown out to form a reservoir. This reservoir or bulb is filled with mercury, and heat applied until the mercury expands and fills the tube, when it is sealed with a blowpipe. After filling, the tube is laid aside for some time to allow the glass to contract, when it is ready for graduation. Two points must be fixed, which represent definite temperatures and which can always be reproduced. These are the temperature of melting ice and of distilled water boiling under a pressure of 760 mm. In the Centigrade (Celsius) thermometer the interval between these fixed points is divided into 100 equal parts, called degrees. Degrees below zero are designated by prefixing the minus sign; thus, $-10^{\circ}\text{C}.$ means ten degrees below the freezing-point of water.

Although the Centigrade scale is generally used by chemists and physicists, that devised by Fahrenheit is in common use in this country. The higher fixed point is that of the temperature of boiling water, but the zero is that indicated by a mixture of equal parts of sodium chloride and pounded ice, the interval between the two being divided into 212 degrees. According to Fahrenheit's scale ice melts at 32° ,

therefore 180 degrees are equal to 100 degrees Centigrade, or 1 degree F. is equal to $\frac{5}{9}$ degree C. In converting degrees Fahrenheit into degrees Centigrade 32 must first be subtracted, in order that the degrees may both count from the same part of the scale. Then, as 1 degree F. is equivalent to $\frac{5}{9}$ degree C., it is only necessary to multiply by 5 and divide by 9. Conversely, to convert degrees Centigrade into degrees Fahrenheit we multiply by 9, divide by 5, and add 32.



FIG. 30.—STANDARD ROSE BUNSEN.



FIG. 31.—SAFETY BUNSEN.

Heating appliances.—The chief sources of heat employed in pharmaceutical operations are gas and steam. Gas is used in the many types of Bunsen burners; in these, gas is burnt with sufficient air to produce a non-luminous flame possessing great heating power. Fig. 30 shows a standard rose Bunsen; the flame holes are protected by a rim, and slope downwards to prevent wet running into the burner, as so often happens when liquids boil over. The correct distance between the bottom of the vessel and the top of the flame is half an inch. Fig. 31 illustrates what is known as a safety Bunsen; in this burner the gas can be turned down to a mere flicker without lighting back, but when turned fully on a flame seven or eight inches high is obtained. For heating vessels of large size a triple concentric burner,



FIG. 32.—TRIPLE CONCENTRIC BURNER.

as fig. 32, is of service. Each ring is provided with a separate tap, so that the heating capacity may be regulated at will.

Small vessels may be supported by tripods (fig. 33), or by the

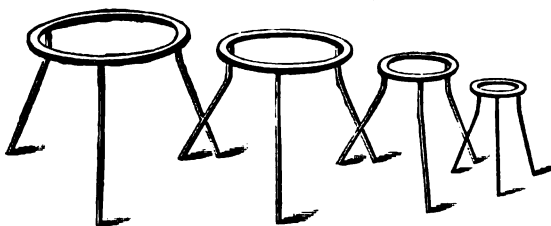


FIG. 33.—TRIPODS.

contrivance shown in fig. 34. This consists of a small 'Bunsen' affixed to a standard. The burner may be used for heating flasks, etc.; a ring support is supplied which may be raised or depressed as desired, or the burner may be bent over at a right angle, when it may be utilised for a sealing jet. This is a useful arrangement, as the wax, being melted in a colourless flame, is not darkened. For

heavier work a retort stand may be used. That illustrated at fig. 35 has the iron supporting rod surrounded by a stout brass tube to

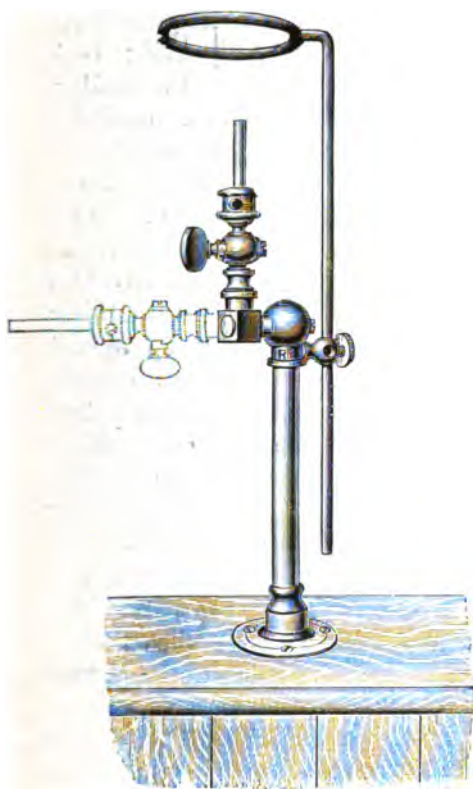


FIG. 34.—BURNER AND SUPPORT FOR DISPENSING BENCH.



FIG. 35.—RETORT STAND.

which the rings are clamped. By means of this tube the rings may all be raised or lowered simultaneously, while each ring may be removed separately.

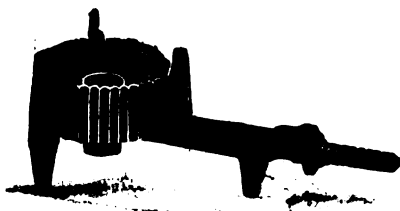


FIG. 36.—ARGAND BUNSEN.



FIG. 37.—SPIRIT LAMP.

The burners hitherto described require the vessels to be supported by tripods or other device at the correct distance above the flame.

This is occasionally inconvenient, and the type of burner shown in fig. 36 was specially designed to overcome the objection.

Spirit lamps.—When a gas supply is not convenient; spirit lamps are frequently employed for small operations. For melting sealing-wax, etc., the familiar glass lamp, fig. 37, is generally used; but since the introduction of the 'Barthel' and other lamps of a similar type, heating operations of much greater magnitude are possible. Barthel's methylated spirit burner (fig. 38) is perfectly safe, and is said

to give an approximate temperature of 1300°C . The container is filled with methylated spirit, connected with the burner by flexible metallic tubing, and hung up about three feet above the bench. To light up, first open the tap beneath the container, allow time for the spirit to fill the tube, then give the regulating screw on the burner half a turn to the left, and let some spirit overflow into the saucer until it is about one-third filled; then close the regulating screw and ignite the spirit in the saucer.



FIG. 38.—BARTHEL'S METHYLATED SPIRIT BUNSEN BURNER.

This having burnt out, open the regulating screw again, and set light to the spirit vapour escaping at the mouth of the burners. By the regulating screw the flame can be made large or small, but it should never be less than an inch and a half. When the burner has been lit, any spirit remaining in the parts of the burner outside the regulating screw will flare up, but will soon burn out. The flame may be unsteady just at first, but quickly becomes perfect. This unsteadiness must not be mistaken for the irregular yellowish flame which appears if the burner has not been sufficiently warmed up; in the latter case turn the flame down a little until the burner is sufficiently heated, and vapour comes off uniformly.

Sand-baths.—When for any reason it is undesirable to allow the flame to impinge directly on the bottom of the vessel, an iron or copper dish of slightly concave shape containing sand may be interposed. Aluminium or copper filings conduct the heat more readily, and the bath is under better control.

Furnaces.—For operations in which a greater heat is required than is afforded by an ordinary Bunsen burner, small gas furnaces are employed. A muffle furnace, as fig. 39, is a most useful adjunct

to a pharmaceutical laboratory, as it can be utilised at all temperatures from a cherry-red to a white heat. The burner consists of a circle of gas jets arranged so as to leave a central space, in which a fireclay block is fitted to form a solid support for a crucible, or over which a muffle may be placed exactly in the focus of heat. To obtain the best results the flue should not be less than six feet high. The furnace has

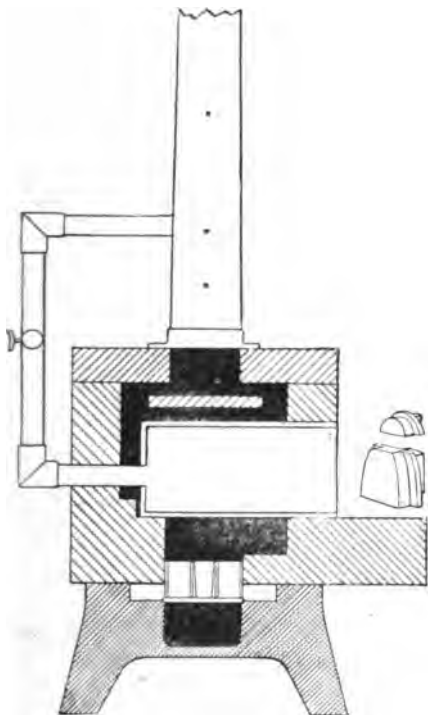


FIG. 39.—GAS MUFFLE FURNACE.

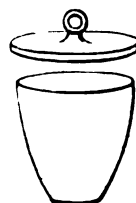


FIG. 40.—PORCELAIN CRUCIBLE.



FIG. 41.—BATTERSEA CRUCIBLE.

two holes at each side, and can be used with two combustion tubes at once. For ordinary work platinum or porcelain crucibles (fig. 40) are employed, but for fusing caustic alkalies *silver* or nickel dishes or crucibles are necessary. Care must be taken not to use too high a temperature, to avoid danger of melting the silver. Moist precipitates should never be introduced directly into the furnace, but must first be dried in a water or air oven. If this is not attended to, the loss by spurting will be very considerable, besides the danger of cracking the muffle. A coarser form of crucible is illustrated at fig. 41.

Should a gas furnace such as the above not be available, ignitions and fusions may be conducted over a powerful Bunsen, the heat being confined by building an extemporaneous furnace round the crucible, as illustrated at figs. 42 and 43. Over a Bunsen, such as fig. 31, place an iron tripod, as fig. 33, and on this burner build a furnace to suit

the height of the crucible. Place the grate A (fig. 42) on the tripod, and on this the cylinders B and C, lastly the cone D. A tail-piece, E,

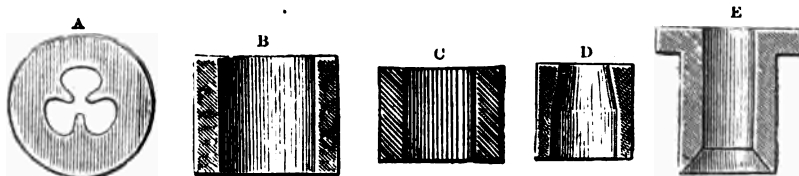


FIG. 42.—FIRECLAY CYLINDERS, ETC., FOR BUILDING EXTEMPORANEOUS FURNACES.

may be added with advantage for high temperatures, but is not absolutely necessary. Fig. 43 shows such a furnace in operation.

Water-baths.—For operations requiring a temperature below 100°C . a water-bath is commonly employed. This may consist of an ordinary copper saucepan (fig. 44), provided with concentric rings,

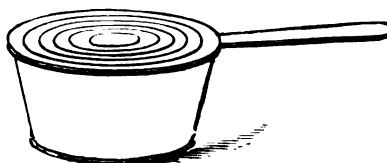


FIG. 44.—COPPER SAUCEPAN WITH RINGS.



FIG. 43.—EXTEMPORANEOUS FURNACE IN USE.



FIG. 45.—WATER-BATH WITH CONSTANT-LEVEL APPARATUS.

to adapt it for use with dishes and flasks of various sizes. Fig. 45 shows a conical water-bath, which is useful for melting ingredients for suppositories, etc.; it only holds a small quantity of water, and is very rapidly heated, the water being kept at a constant level by the apparatus shown at the side. Figs. 46 and 47 illustrate two excellent forms of water-bath specially designed for melting ointments. In the above forms of apparatus the upper vessel is heated by the vapour of the boiling water, consequently its contents never quite reach 100°C . When convenient the water-bath should be provided with a constant-level apparatus, as fig. 45, to avoid the necessity for constant refilling. A home-made apparatus that will answer every purpose

may be constructed as follows : Procure a length of glass tubing about one inch bore and six inches long, and fit it with two rubber corks. A piece of glass tubing, bent as shown in fig. 48, is passed through

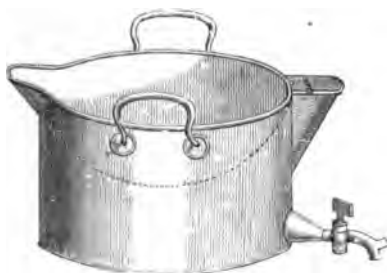


FIG. 46.—WATER-BATH.

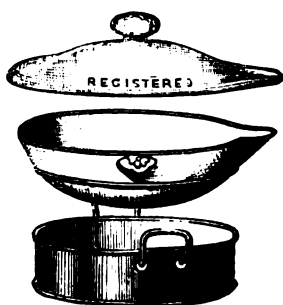


FIG. 47.—WATER-BATH.



FIG. 48.—CONSTANT-LEVEL APPARATUS.

a hole in the upper cork, and serves for the supply. Two tubes, one straight and of wide bore, the other narrower and bent at an angle, are fitted to the lower cork. The wide tube serves as the waste, the narrow tube is intended to feed the water-bath. When the connections are made and water turned on, it enters by the upper tube, and is directed against the sides of the glass reservoir, which it partially fills, finally overflowing by the waste pipe. The feed is connected with the water-bath, which may be at any distance away ; by raising or lowering the apparatus the water is maintained at any desired level, the final adjustment being conveniently made by pushing the waste-pipe further in or withdrawing it, as the water level is to be increased or diminished.

Vaporisation.—The passage of a liquid into the gaseous state is termed *vaporisation*, the term *evaporation* generally being restricted to the *production of vapour at the surface of a liquid*, and *ebullition* to its *rapid production in the mass of the liquid* itself. If the vapour pressure of the liquid is less than the external (air) pressure, evaporation can only take place at the surface. This change of state is, therefore, distinct from ebullition, in which the *internal* vapour pressure

of the liquid is greater than the *external* pressure of the air. Under this condition steam bubbles are formed *in* the liquid—i.e., the boiling-point has been reached.

Evaporation takes place at practically all temperatures, while the boiling-point of any pure substance does not vary provided the pressure remains constant.

When water is heated in a flask the portion first heated expands, and, becoming lighter, rises vertically; to replace this warm water the colder portion round the sides of the flask descends, and an *upward* current is formed directly over the source of heat while *downward* currents are set up all round the circumference. In this way circulation is promoted, every portion of the liquid being in turn brought over the source of heat. Such currents are termed *convection currents* (fig. 49).

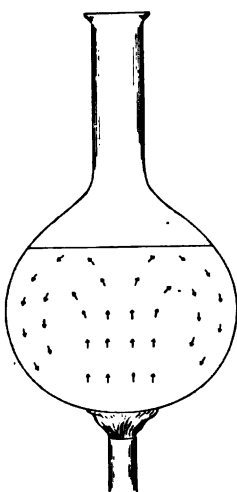


FIG. 49.—DIAGRAM SHOWING CONVECTION CURRENTS IN FLASK.



FIG. 50.—EVAPORATING BASIN

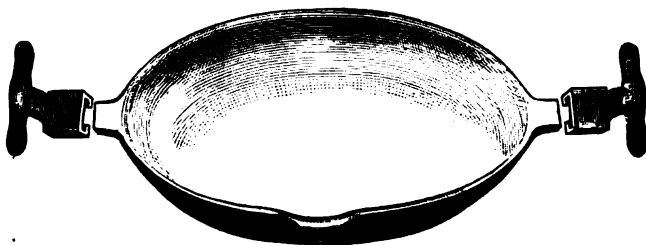


FIG. 51.—EVAPORATING BASIN

After a time the layers of water at the bottom of the flask are raised to boiling-point, the bubbles of steam condensing with a sharp sound as they rise to the cooler layers. When this takes place very rapidly it is termed *simmering*. The same phenomenon occurs when steam under pressure is led into cold water. As the temperature rises the *bubbles of steam escape from the surface*, when the water is said to be in ebullition, or to boil.

The rate at which evaporation takes place depends upon

- (a) *The area of surface exposed.*
- (b) *The humidity of the surrounding atmosphere.*
- (c) *The relative vapour and atmospheric pressures.*

This being so, it is found that the same quantity of liquid evaporates more rapidly

- (a) *In a wide shallow dish than in a narrow deep one.*
- (b) *If air is blown over the surface, the evaporated particles being carried away as quickly as formed.*
- (c) *If heated, the vapour pressure being increased. It evaporates still more rapidly if at the same time the atmospheric pressure is reduced. See Vacuum Pans.*

In evaporation the escaping vapour is disregarded, but in *distillation* it is condensed and collected. *Desiccation* is the term applied to the extraction of water from solid bodies, as plant substances, etc. *Exsiccation* is generally restricted to the removal of combined water from crystallised salts, etc.

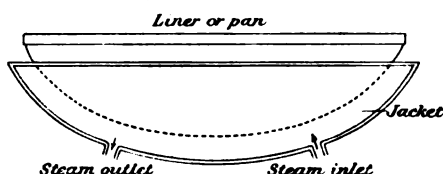


FIG. 52.—DIAGRAM OF JACKETED STEAM-PAN.

For evaporating small quantities of liquids, earthenware or porcelain basins may be employed, as fig. 50. In larger bulks, tinned-copper, aluminium, or enamelled-iron dishes are used. Fig. 51 illustrates a dish with detachable handles, which are affixed when it is necessary to remove the vessel from the source of heat.



FIG. 53.—STEAM-PAN.

On a manufacturing scale evaporation is generally conducted in shallow steam-jacketed pans. As will be seen by the diagram (fig. 52), a jacketed pan consists of a *liner*, which may be of tin, copper, aluminium or enamelled iron, and a *jacket*, which is generally made of cast iron. Steam after admission impinges on a baffle plate and circulates around the liner before escaping.

Table of Temperatures of Steam in degrees Fahrenheit corresponding to absolute pressure in pounds per square inch. The second column gives the approximate pressure above atmosphere

Absolute Pressure in lb. per sq. in.	Approximate Pressure in lb. per sq. in. <u>above</u> Atmosphere	Temperature in degrees F.	Absolute Pressure in lb. per sq. in.	Approximate Pressure in lb. per sq. in. <u>above</u> Atmosphere	Temperature in degrees F.
1	—	102.02	38	24	264.09
2	—	126.30	39	25	265.65
3	—	141.65	40	26	267.17
4	—	153.12	41	27	268.66
5	—	162.37	42	28	270.12
6	—	170.17	43	29	271.56
7	—	176.94	44	30	272.97
8	—	182.95	45	31	274.35
9	—	188.36	46	32	275.70
10	—	193.28	47	33	277.04
11	—	197.81	48	34	278.35
12	—	202.01	49	35	279.64
13	—	205.93	50	36	280.90
14	—	209.60	51	37	282.15
14.07	—	212.00	52	38	283.38
15	1	213.07	53	39	284.59
16	2	216.35	54	40	285.78
17	3	219.45	55	41	286.95
18	4	222.42	56	42	288.11
19	5	225.26	57	43	289.25
20	6	227.96	58	44	290.37
21	7	230.57	59	45	291.48
22	8	233.07	60	46	292.57
23	9	235.48	61	47	293.65
24	10	237.80	62	48	294.72
25	11	240.05	63	49	295.77
26	12	242.23	64	50	296.81
27	13	244.33	65	51	297.83
28	14	246.38	66	52	298.84
29	15	248.36	67	53	299.84
30	16	250.29	68	54	300.83
31	17	252.17	69	55	301.81
32	18	254.00	70	56	302.77
33	19	255.78	71	57	303.73
34	20	257.52	72	58	304.67
35	21	259.22	73	59	305.60
36	22	260.88	74	60	306.53
37	23	262.51			

The steam pressure in general use in pharmaceutical laboratories is about 25 lb. to the square inch, giving an approximate temperature of 130° C. Where the boiler pressure greatly exceeds this, a reducing valve is interposed.

The *rate of evaporation* is also influenced by the metal of which the liner is made, the relative conductivities being as follows :

Silver	100.0	Tin	14.5
Copper	73.6	Iron	11.9
Brass	23.6	Platinum	8.4

From this it will be seen that the *best* results are obtained with a copper liner—silver being too expensive for general use—and iron jacket ; the *worst* with an enamelled-iron liner, the silicated compound forming the enamel being a very poor conductor of heat. Fig. 53 and fig. 54 illustrate two evaporating pans of ordinary types.



FIG. 54.—TILTING STEAM-PAN.

For the preparation of vegetable extracts liners should be made of tin, tinned-copper, aluminium, or enamelled iron. If a copper liner is employed, acid plant-juices, and especially resinous extracts, attack

the metal, considerable amounts being taken into solution, sometimes changing the colour of the preparation. Ordinary extracts, such as those of belladonna, henbane, liquorice, etc., may be concentrated with safety in copper pans, but copper is unsuitable for acid extracts, as extract of aloes, etc. Should the liner be made of aluminium, the stirrers, ladles, etc., must either be made of the same metal or of wood: if made of copper, a 'couple' is formed and the amount of metal dissolved is largely increased. Liquid extract of cinchona should only be concentrated in enamelled-iron or earthenware pans. Copper and iron are inadmissible, while if tin is used, the tin chloride formed, precipitates the whole of the extractive.

Steam coils are sometimes used for heating, and possess the advantage of being readily adaptable to almost any form of vessel. They are commonly used for boiling the contents of wooden vats, cisterns, etc., during the preparation of decoctions, etc.

Evaporation is accelerated by keeping the liquid in constant motion. Small bulks may be stirred by hand or by a water-motor, of which 'Chicago's Top' (fig. 55) is a good example. With a head

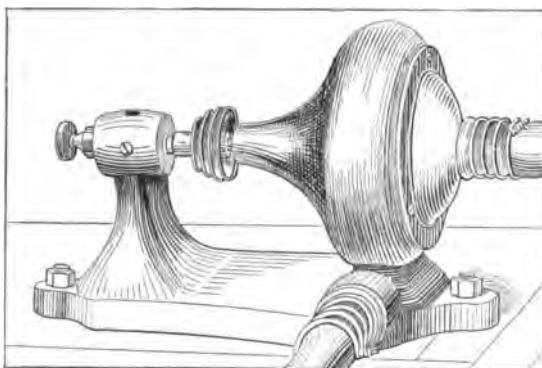


FIG. 55.—WATER-MOTOR.

of 65 feet the motor uses 50 gallons an hour, giving 285 foot-pounds per minute and about 2000 revolutions. When water is not available, one of the many forms of hot-air engine may be employed.

Sumner's evaporating tray (fig. 56) is a device for evaporating large quantities of liquid with the shortest exposure to heat and also without stirring. It consists of a series of copper tubes brazed together and so connected that steam circulates through their entire length. The tray stands on a frame, to which is affixed an elevating screw by means of which it can be tilted to any angle. The liquid to be evaporated falls upon the tray from a trough at the higher end and gravitates slowly to the spout. A tray measuring 4 feet by 2 feet, with steam at 30 lb. pressure, will evaporate about 20 gallons of water an hour.

Evaporation in vacuo.—The boiling-point of a liquid depends upon the external pressure. Water boils at 100° C. under an atmospheric pressure of 760 millimetres. If the pressure is increased the boiling-

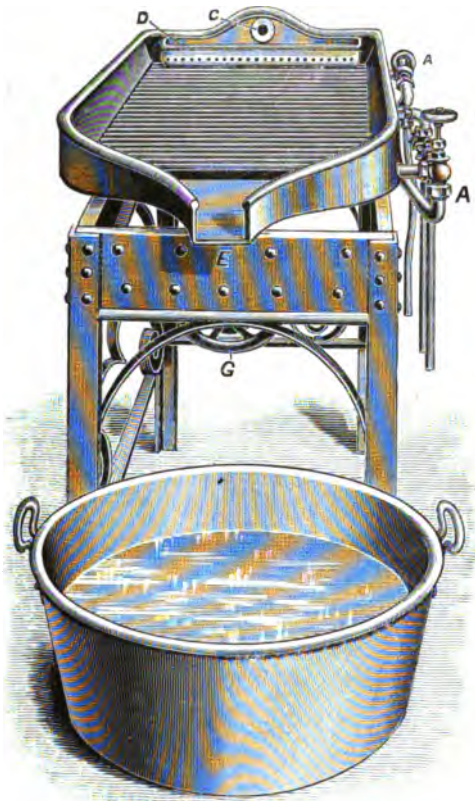


FIG. 56.—SUMNER'S EVAPORATING TRAY.

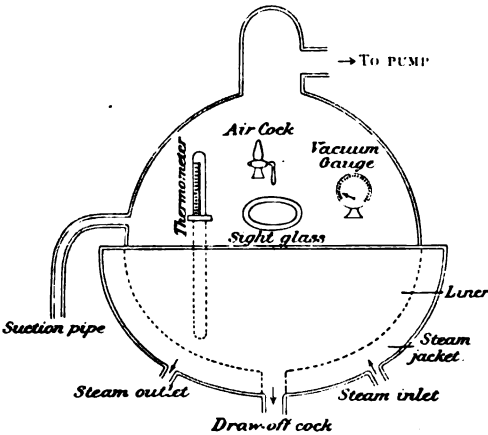


FIG. 57.—DIAGRAM OF VACUUM PAN.

point is raised, while if the pressure is reduced the boiling-point is lowered. This fact is made use of in many pharmaceutical operations for the rapid evaporation of certain liquids, liable to be injured by heat, at temperatures considerably below their boiling-points. If such liquids are heated to about 60° or 70° C. in an open vessel, evaporation only takes place very slowly *from the surface*, but if the atmospheric pressure is reduced, the vapour pressure of the liquid becomes relatively greater, and the liquid *boils rapidly* at these low temperatures.



FIG. 58. — VACUUM PAN AT WORK.

This is termed evaporation *in vacuo*, and it affords one of the most efficient devices for getting rid of superfluous moisture, answering equally well for the concentration of liquids or for the drying of damp substances. Fig. 57 is a diagram showing the construction of a vacuum pan. As will be seen from the diagram, it consists of a liner and jacket, but over the liner is an air-tight hood connected with a pump. The liquid to be concentrated is sucked in; as soon as steam is admitted to the jacket and the pump set going, the pressure in the

pan falls and the liquid boils, the vapour and liberated air being drawn away and the former (if necessary) condensed. With a vacuum of 50 millimetres of mercury, infusion of malt or ergot will boil furiously

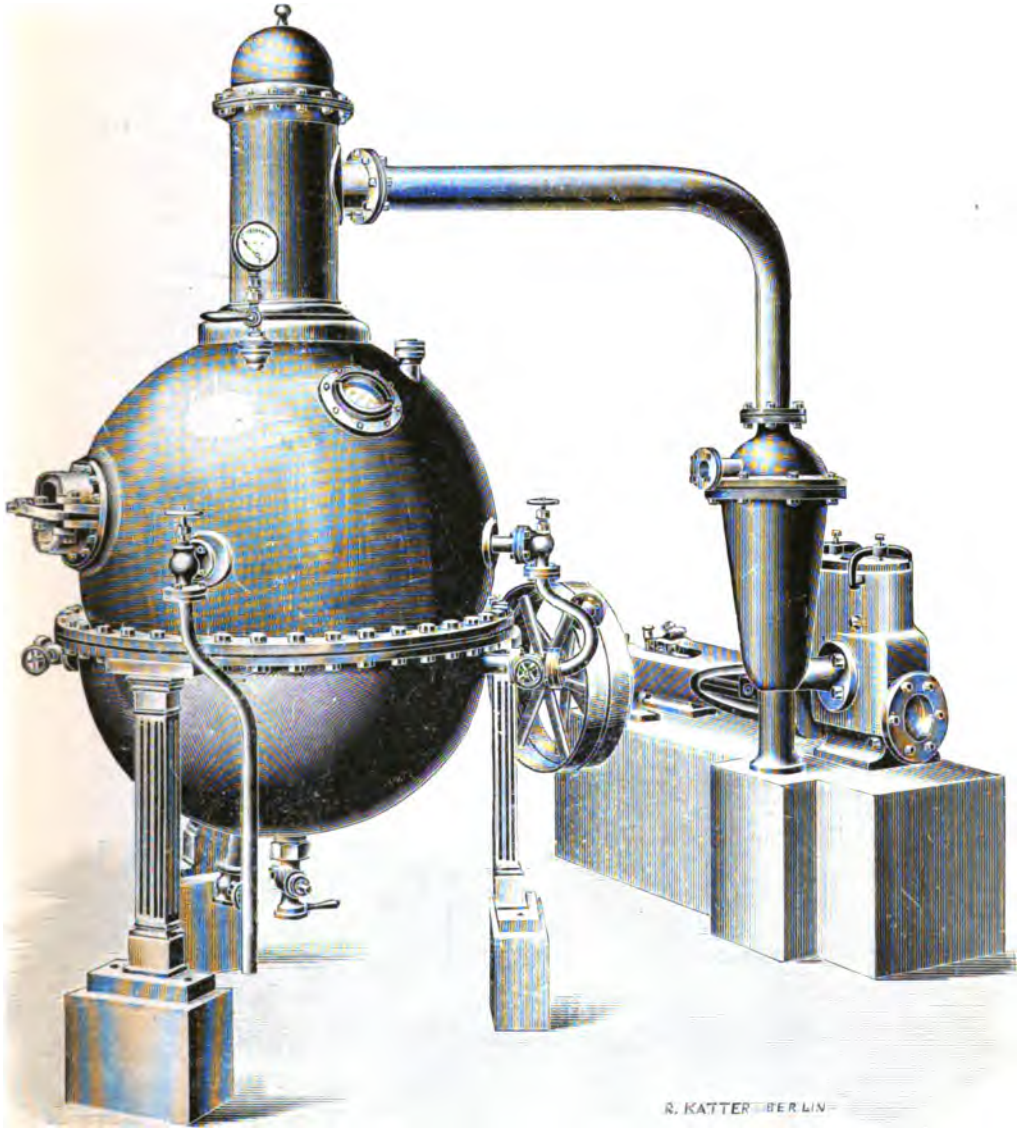


FIG. 59. — MALT-EXTRACT VACUUM PAN.

at about 60° C. Fig. 58 shows a vacuum pan at work, and fig. 59 a reproduction of a large malt-extract vacuum pan.

Evaporation *in vacuo* is especially suitable for the concentration of preparations of malt, ergot, senna, etc., as well as for drying vegetable

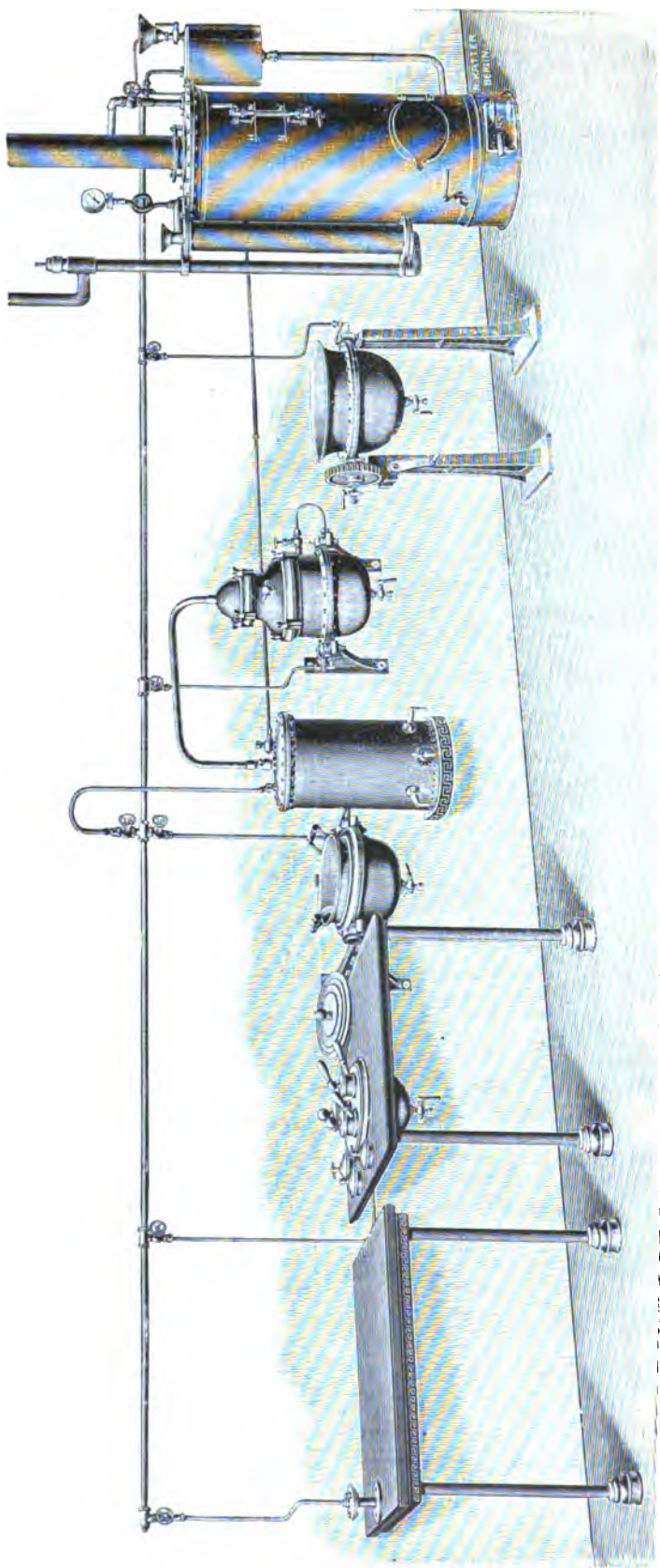


FIG. 60.—MODEL PHARMACEUTICAL LABORATORY.

extracts, as extract of malt, cascara, henbane, etc. As regards efficiency, it may be taken that a good vacuum pan will evaporate about twice as much per square foot as an open pan under similar conditions.

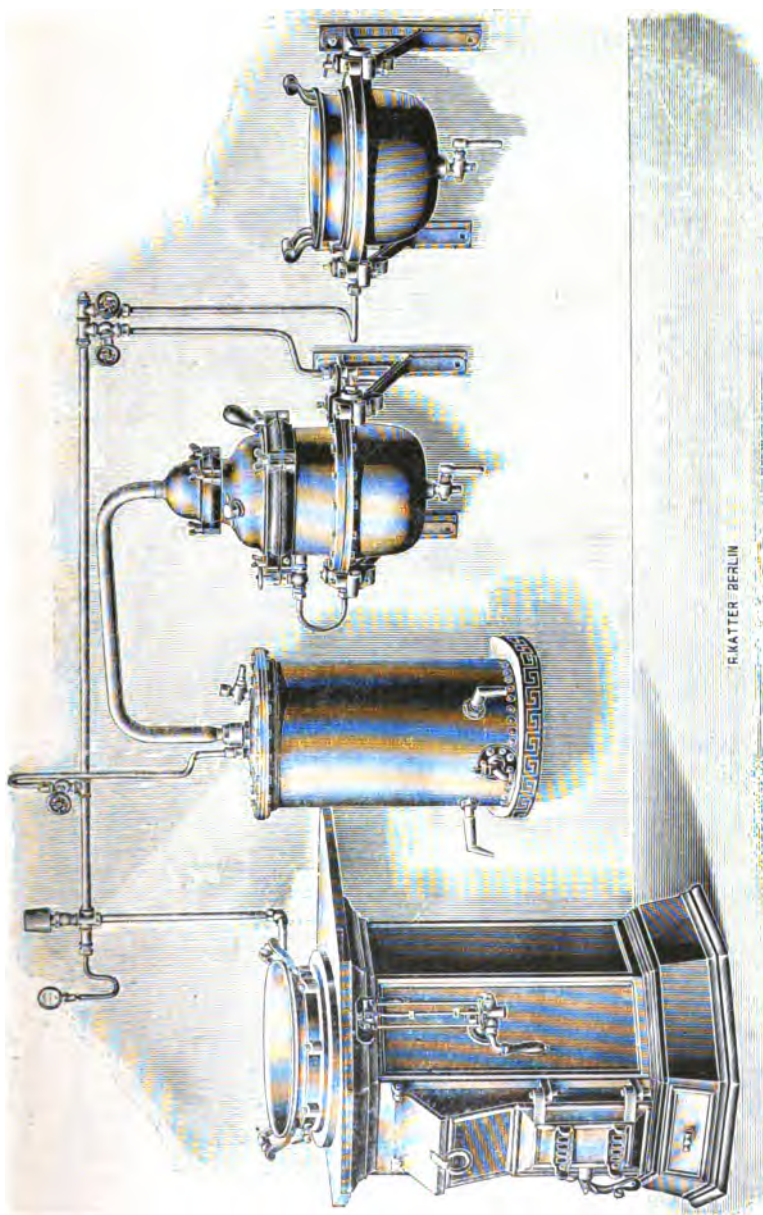


FIG. 61.—MODEL PHARMACEUTICAL LABORATORY.

As from the illustrations of large manufacturing apparatus it might be inferred that the retailer is placed at a disadvantage, the author appends drawings of three model steam plants (figs. 60, 61, and 62).

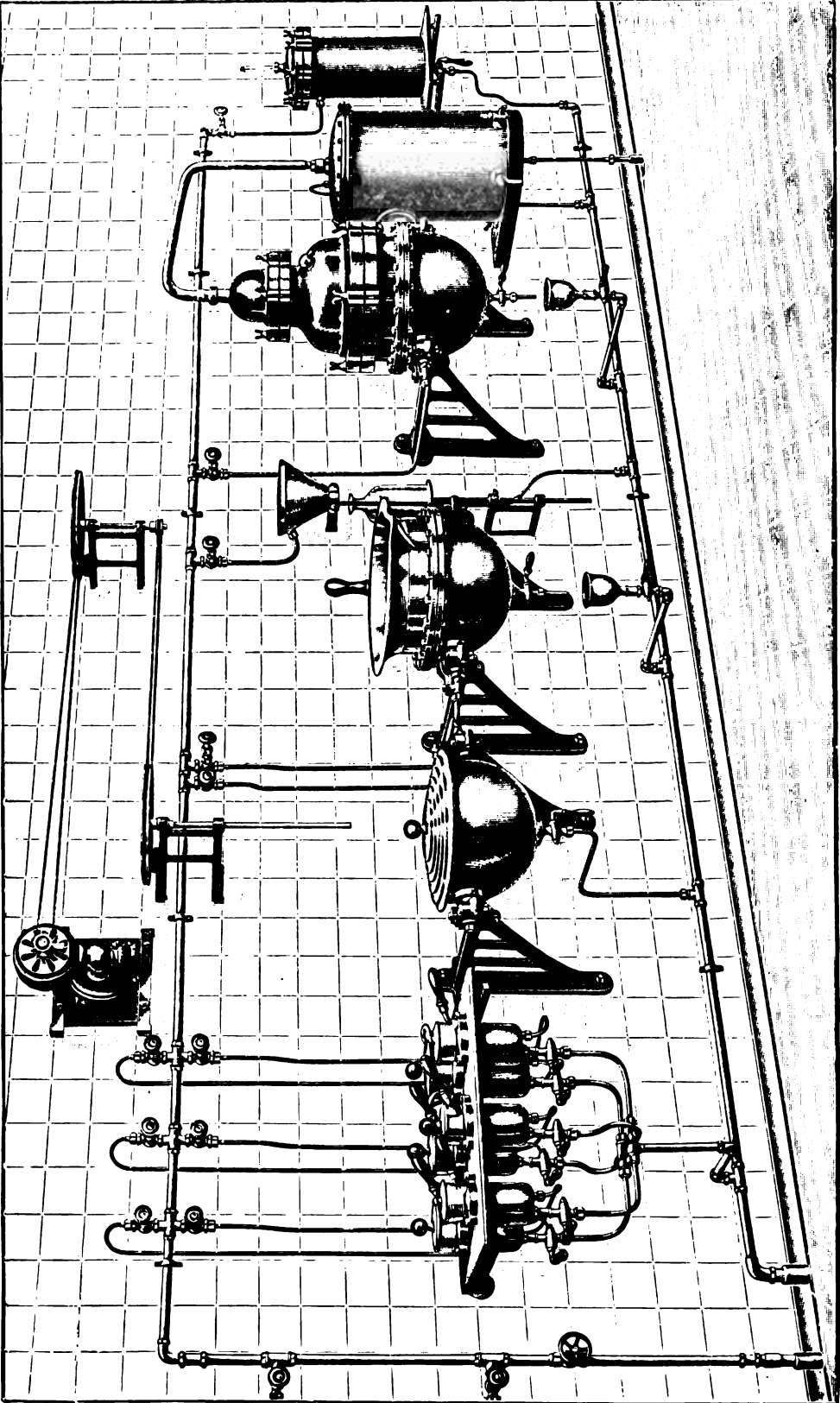


FIG. 62.—MODEL PHARMACEUTICAL LABORATORY.

Distillation

Distillation is the name given to the operation of vaporising a liquid by heat and subsequently condensing the vapour. The process is employed for the separation of liquids from solids as well as of liquids from liquids. In the latter case complete separation can only be effected when the boiling-points of the respective liquids differ materially. The evaporating vessel is generally termed a *still* or *retort*, and the condensed liquid the *distillate*.

One gramme of water requires 100 heat units to raise it from 0° to 100° C., and 537 more units to convert the boiling water into steam at 100° C. Conversely, 1 gramme of steam at 100° C. parts with 537 heat units in condensing to water at 100° C. This is generally expressed by saying that the *latent heat of steam* at 100° C. is 537 heat units.

If water is placed in a boiler and converted into steam, and the vapour passed into a condenser, it will be found that the cooling-water at the exit-pipe becomes very hot. Every pound of steam at 100° C. in condensing to water at 100° C. will heat over half a gallon of cooling-water to boiling-point. It is thus evident that to obtain efficient condensation, especially with cooling-water at ordinary atmospheric temperature, the supply must be very considerable.

The volume of cooling-water required for the condensation of the

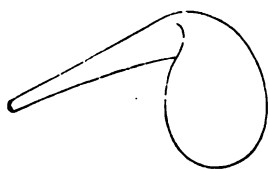


FIG. 63.

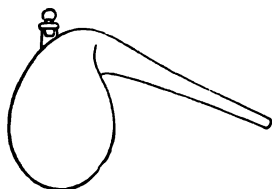


FIG. 64.

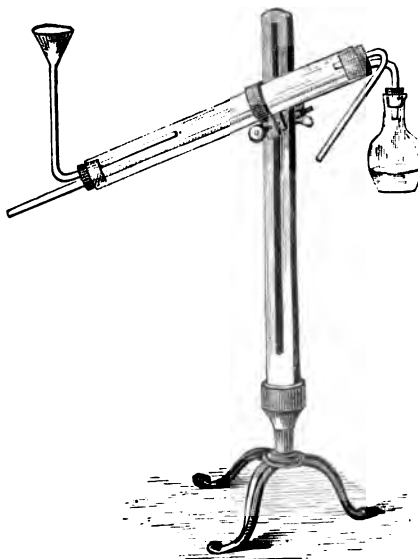


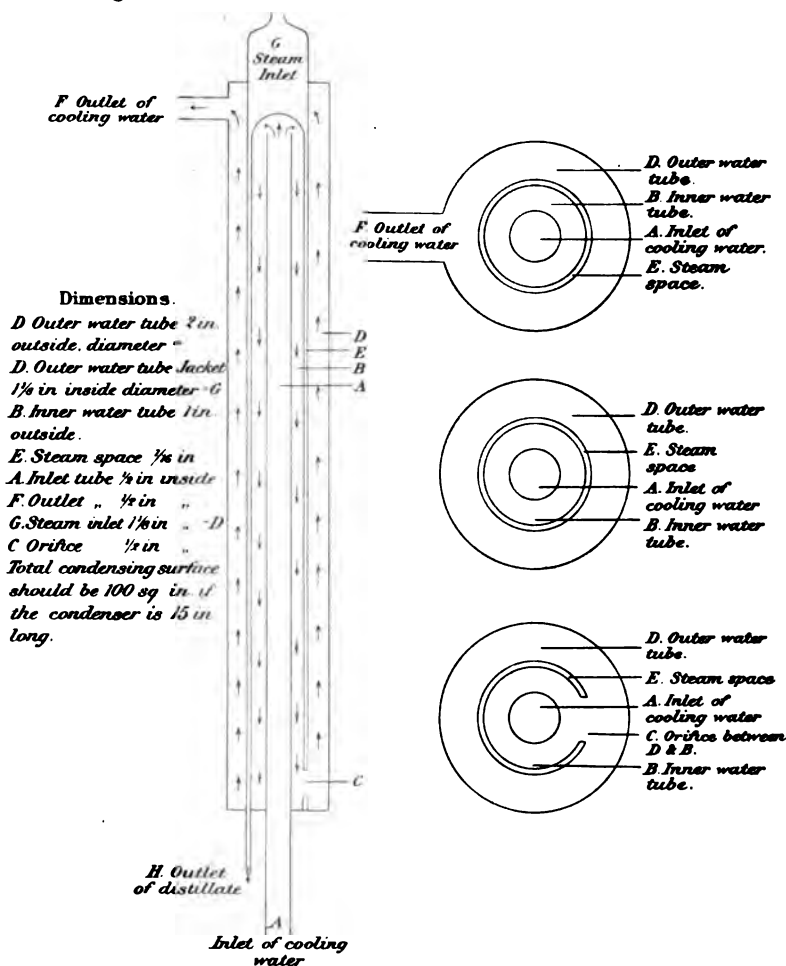
FIG. 65.

vapours of different liquids varies enormously, as shown in the following table of latent heats :

Water	536·67	Ether	90·45
Alcohol	202·40	Oil of Turpentine	74·00
Acetic Acid	101·91		

Small quantities of liquids from an ounce to several pints may be distilled from glass flasks or retorts, figs. 63 and 64.

The simplest form of condenser is shown at fig. 65, and is known as Liebig's. It consists of a glass tube, which may be narrowed at one end and somewhat funnel-shaped at the other. This tube is fixed by means of corks or rubber bands inside a larger tube of glass or copper, the space between the two tubes being constantly supplied with cooling-water.



A more efficient form of condenser was devised by the author some years ago, and various modifications of it are employed in many technical operations. It practically consists of an *annular* steam space, the inner and outer sides of which are contiguous to cooling surfaces, thus distinguishing it from other forms of condensers in which the steam space is cylindrical and contiguous to only one condensing surface. Reference to the diagram (fig. 66) shows that the cooling-water first ascends the pipe A, impinges on the under side of the dome, whence it returns down the tube B, through an orifice in the annular steam space, C, to the jacket, D, which it traverses before escaping at F.

If the course indicated by the arrows is followed, it will be evident that the cooling-water does double duty. In the first place, owing to the manner of its projection against the under side of the dome, it brings successive units of cold water into direct contact with the successive units of steam which bombard the opposite side. In the second place, the water in its downward course cools the inner side, and in its upward course the outer side, of the annular steam space.

Steam enters at G, striking directly on the cold dome, where it is robbed of most of its heat and practically condensed. The condensed water is then pushed down the annular steam space until it escapes at H. Too much importance cannot be attached to the part played by the dome, as it not only enables the steam and cooling-water to be brought into intimate contact, but, owing to its shape, the film of condensed water is brushed away as soon as formed, leaving the surface clean and in good condition for transmitting heat. In most other forms of condenser this film of condensed liquid remains, and, owing to its low conductivity, impairs the efficiency.

The advantage of a condenser of this type over a worm condenser of the ordinary pattern is exemplified by the following experiment, in which the condensing surfaces (100 square inches) were equal, and conditions precisely similar:

	Author's Pattern	Worm Condenser
Cooling-water, gallons per hour . . .	90	90
" " temperature at inlet . . .	52° F.	52° F.
" " " " outlet . . .	130° F.	98° F.
Condensed water, gallons per hour . . .	7.5	3.8
" " temperature at outlet . . .	176° F.	164° F.
Steam pressure in lb. per square inch . . .	12	12
Duration of experiment . . .	1 hour	1 hour

After the test had proceeded for an hour the cooling-water was increased to 240 gallons per hour, the steam pressure being raised to 25 lb. per square inch. The improved pattern condensed over

eleven gallons per hour. The worm pattern, on the other hand, could not condense more than four gallons per hour, steam blowing through, although the cooling-water was considerably below boiling.

Water stills.—A good supply of distilled water is of the first importance in a pharmaceutical laboratory. Fig. 67 shows Shears'



FIG. 67. — SHEARS' AUTOMATIC STILL.

automatic still, specially designed to meet the requirements of retail pharmacists. It consists of a copper still heated by means of a gas burner, the steam being condensed in a block-tin worm. Between the still and the condenser is a cistern, which is connected to the water main, the supply being regulated by a ball-valve. The water enters the condenser at the bottom and overflows by a pipe near the top into the still. By this arrangement there is an automatic feed of warm water.

This kind of still is, however, not as efficient as it might be, since no real use is made of the heat stored up in the steam, and a good deal of water is wasted in the condenser. It has been shown that every pound of steam at 100° C. in condensing to water at 100° C. will theoretically heat half a gallon of the cooling-water to boiling-point. *Practically* this result is not obtainable, owing to loss of heat by radiation; nevertheless, the greater portion of this energy can be utilised. The diagram (fig. 68) shows how this is accomplished.

A is a boiler, fed by the constant-supply cistern, and heated in any convenient manner. Steam is generated under *slight* pressure and led into the jacket of B. Part of the steam is condensed, the balance, together with the steam *generated in B*, being in turn led into the jacket of C. Here more steam is condensed in the jacket and some steam generated in its boiler. The whole of the condensed water is

drawn off by ordinary float-valves. With sufficient steam pressure this system of condensation may be extended through seven steps, and the whole of the available energy utilised. It will be seen that

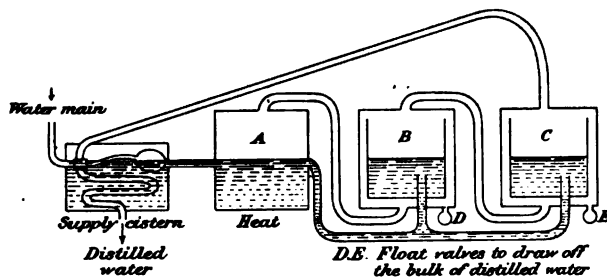


FIG. 68.—DIAGRAM OF CONTINUOUS WATER STILL.

no cooling-water is employed, and the heat stored up in the steam is made use of until steam at atmospheric pressure is reached, when it is condensed by passing it through the supply cistern, the water in which it heats.

Earthenware stills.—Owing to the fragility of glass retorts, it is customary, when treating considerable bulks of liquid that cannot be dealt with in metal stills, to have them made in earthenware—when distilling sweet spirit of nitre, for instance. The body of the still is contained in a cast-iron steam jacket, the joints being made steam-tight with soft rubber bands. The head and arm are generally separate, and require to be luted on to the condensing worm, also of earthenware, which is contained in a wooden vat. Great care must be taken in the fitting-up of these stills to allow for the unequal expansions of the earthenware and metal when heated.

Notes on the use of glass apparatus.—Glass retorts and flasks are not as a rule exposed to the direct heat of a flame, but are protected by nickel or copper gauze. For many operations it is preferable to use a bath of sand or iron-filings, the grains being heaped round the glass.

Certain liquids, when heated to boiling, give rise to the phenomenon of *bumping*. This may be lessened or prevented by the introduction of one or two coils of platinum wire, or a few pieces of pumice previously heated to redness in a crucible. These act mechanically. *Bumping* is peculiarly liable to occur in glass or glazed porcelain vessels. Frequently distillation proceeds quietly because the heated surface offers a number of points at which the vapour is dispersed as soon as formed; but if no such points are presented, and the liquid is not disturbed, superheating takes place, and a large volume of steam is suddenly evolved which throws the liquid violently upward.

Pharmaceutical stills.—Large stills are nearly always made of copper with cast-iron steam jackets. When the still is of considerable size, the heating surface is increased by the introduction of a steam coil. The condenser for a large still is rarely of the old-fashioned type owing to the great waste of cooling-water, which is of economic importance, but generally consists of an upright iron cylindrical jacket packed with longitudinal tubes. On removing the cover the whole of the interior is exposed to view and may be readily brushed out and cleaned. More recently, double condensers of the type described on page 49 have been employed.

Distillation of volatile oils.—Volatile oils—*e.g.*, cloves, caraway, etc.—are distilled in steam. The charge of seeds, etc., is placed on wire gratings; live steam is then blown under the gratings, and carries the volatile constituents into the condenser. Peppermint, lavender, etc., are generally distilled by the growers in large copper stills heated over naked fires, the charge of plant being placed on a false bottom along with a large quantity of water. The mixture of oil and water distils; the oil, which floats on the surface of the receiver, is skimmed off and the saturated water reserved for a fresh charge. Dense woods, as sandal, are first reduced to fine raspings and then distilled in a current of steam, the mass being constantly roused by a mechanical stirrer.

Fig. 69 illustrates a room in a modern essential-oil factory.

The behaviour of injected steam may be explained as follows :

When led directly into cold water it is at first condensed, the latent heat being given up to the water. As soon, however, as 100° C. is reached, as much steam is evolved as is led into it. This is proved by the knowledge (see page 47) that 1 kilo. of steam at atmospheric pressure contains 637 Calories, and if the temperature of the water is taken as t , each kilo. of steam evolves from it $637 - t$ Calories.¹

The following table shows the amount of steam which must be injected to heat 100 kilos. of water at atmospheric pressure, through various temperatures :

10°	20°	30°	40°	50°	60°	70°	80°	90°	100° C.
1·7	3·33	5·0	6·9	9·0	10·75	12·75	15·0	16·8	18·6 kilos.

When saturated steam is blown into a hot mixture of volatile oil, or crushed material containing a volatile oil (*e.g.*, caraway fruit), and water, the volatile oil, although of a higher boiling-point, is mechanically carried over with the steam. This process of carrying away small particles is not vaporisation, the heat of the evolved vapours being but little greater than that of the water alone; it is largely made use of in the distillation of volatile oils, fatty acids, glycerin, benzol, nitro-benzol, etc.

¹ Calorie should not be confused with the gram-calorie or therm.

Destructive distillation is the process of decomposing organic substances in retorts at a high temperature, the volatile products which pass over either escaping as gases or condensing as liquids. The process is one that more nearly concerns the manufacturing chemist

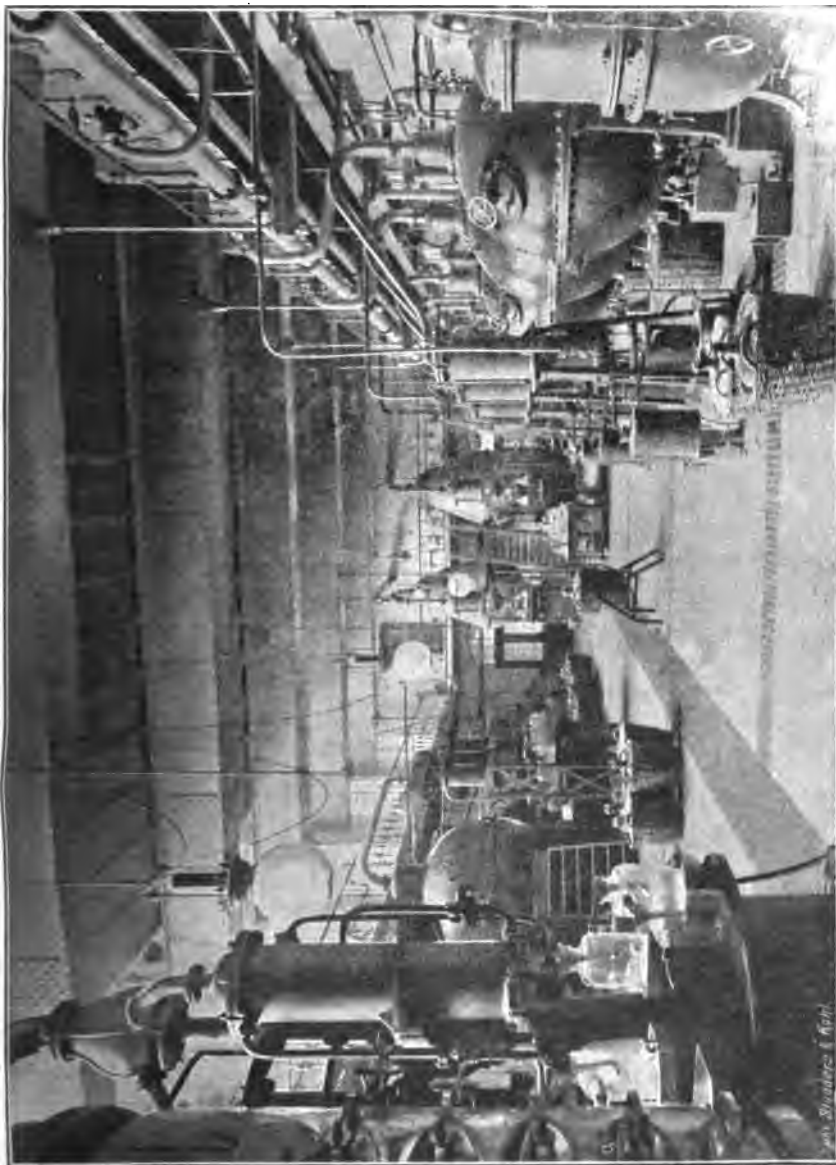


FIG. 69.—VIEW OF A MODERN ESSENTIAL-OIL DISTILLERY (Messrs. Schimmel & Co.'s).

than the pharmacist. On account of the high temperatures employed and the nature of the residues, iron retorts are used. The preparation of acetic acid with its accompanying by-products affords a good

example of the application of this process. Billets of wood are packed in an iron retort or cylinder heated by a furnace. The volatile products are passed through a condenser cooled by water, the condensible portions collected in appropriate receivers, while the gases, consisting of ethylene, acetylene, marsh gas, and other hydrocarbons, are led into the furnace, and serve to economise the fuel. The condensed portions consist of a tarry mixture of empyreumatic oils and phenylic compounds floating on an aqueous substratum. By proper treatment acetic acid, wood spirit, acetone, etc., are obtained from the watery solution, and creosote, etc., from the oily layer.

Exsiccation.—This name is specially given to the process for the removal of water from crystallised salts. Pharmacopœial examples are found in dried alum and dried ferrous sulphate. The process simply consists in exposing the salts to a temperature from 110° to 130° C. over a naked flame or sand-bath. When cold the mass is powdered. These anhydrous salts may be made to reassume their original forms by dissolving them in water, concentrating, and setting aside to crystallise.

Desiccation consists in depriving solid bodies of their moisture at comparatively low temperatures. For drying substances in analy-

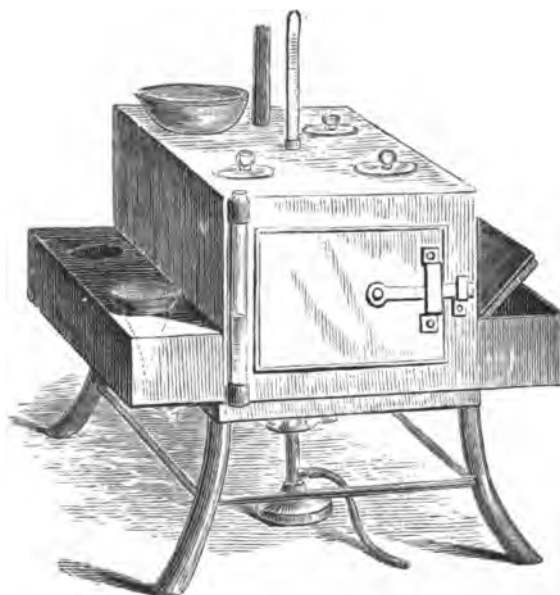


FIG. 70.—COMBINED HOT-WATER BATH AND OVEN.

tical operations water-ovens, as fig. 70, are generally employed. This illustrates the combined water-bath and oven designed by Mr. Wills, of the Somerset House laboratory. It consists of a hot-water bath,

the air-chamber of which measures ten inches wide, seven inches high, and eight inches from back to front, a pair of hot-water funnels, a hot-air box for drying test-tubes, etc., and four openings with covers on the top for evaporating-capsules. It is provided with a water-gauge beside the door, and is supported by a four-legged stool; it is without doubt a most useful piece of apparatus. To avoid the necessity for frequent refilling a constant-level apparatus should be attached as described on page 34. It is impossible to raise the temperature of these ovens higher than that of boiling water, but occasionally it becomes necessary to maintain the temperature within certain narrow limits. For this purpose thermostats controlling the supply of gas to the burner are employed. Fig. 71 shows Bunsen's regulator. In this the temperature is controlled by increasing or diminishing the supply of gas to the burner *d*. The gas enters by *a*, passes into a narrow tube, which is continued for about two-thirds of the length of *b*, and is open at the lower end, where the gas escapes, passing out by the tube *c* to supply the burner *d*. The lower part of the tube *b* is cut off from the upper by a diaphragm containing mercury. A small tube, open at both ends, passes through the diaphragm to the bottom of the mercury. There is a scale and a screw at the upper end of the tube *b*, by which the proper supply of gas can be regulated at the commencement. Supposing the apparatus to be in action as represented by the figure, if the heat becomes greater than is required, the air enclosed above the mercury in the lower chamber expands, drives out the mercury, which rises in the tube *b* and closes the lower end of the continuation of the supply pipe *a*. In order to prevent extinction of the flame the inner supply pipe is either pierced with a small hole which always remains open, or the lower part of the tube is provided with fine slits which permit a slight passage of gas when the bottom is closed. When the heat falls in the bath the air enclosed in the tube *b* contracts, the mercury falls, and a greater supply of gas is admitted to the burners.

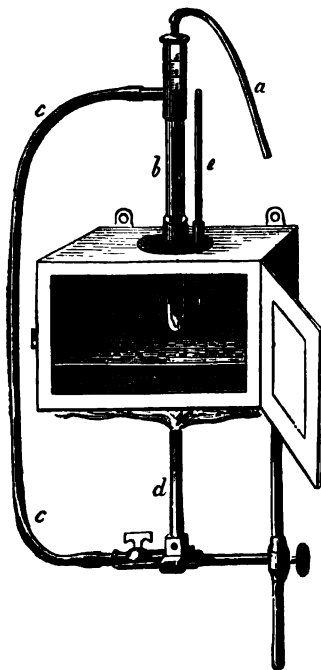


FIG. 71.—HOT-AIR OVEN WITH THERMOSTAT.

When the temperature at which the substance is to be dried exceeds 100° C., hot-air ovens are often used, as fig. 71. These

practically only differ from water ovens in that, in the space between the walls, air circulates instead of water.

Precipitates, etc., after drying in water or air ovens are often placed in desiccators of the form shown in fig. 72, where they not only

cool, but lose the last traces of moisture. In the form shown the drying agent is fused calcium chloride, but sulphuric acid may be used if preferred.

An excellent form of desiccator is easily made by cutting an ordinary Winchester-quart bottle about halfway, by filing a deep nick and then leading a crack around the middle by means of a red-hot wire. The sharp edge of the upper half must then be ground perfectly smooth on a glass plate with emery and water. A rubber cork, fitted with a glass tube provided with a stopcock, is then placed in the neck. Now take a shallow ointment jar,



FIG. 72.—DESICCATOR.

and half fill it with fused calcium chloride, cover it with a piece of perforated zinc, and stand under the improvised bell jar. The desiccator is now ready for use, and may be employed in the usual way; but if it is required to hasten desiccation or effect evaporation of small quantities of volatile liquids at ordinary temperatures, as in the assaying of alkaloids, the stopcock may be opened and the glass tube connected with a Korting's or other filter-pump. In this way a partial vacuum ranging to about twenty-eight inches of mercury is rapidly attained, in which volatile bodies evaporate at a great rate. To prevent entrance of air the surface of the glass plate must be smeared with soft paraffin.

For drying drugs for powdering, etc., large chambers, heated by steam pipes or brick flues, are made use of. The drugs are exposed in shallow trays placed on perforated shelves, the moist air being constantly removed by a fan. The most convenient temperature for general work of this description is from 25° to 30° C. For drying certain substances injured by heat, a vacuum desiccator, as fig. 73, is employed. This consists of a steam-jacketed vessel provided with a closely fitting door. The material to be dried—extract of malt, for instance—is placed on shallow trays, the door closed, and steam admitted to the jacket. As soon as the pump is

set going the pressure in the desiccator falls and vaporisation proceeds rapidly.

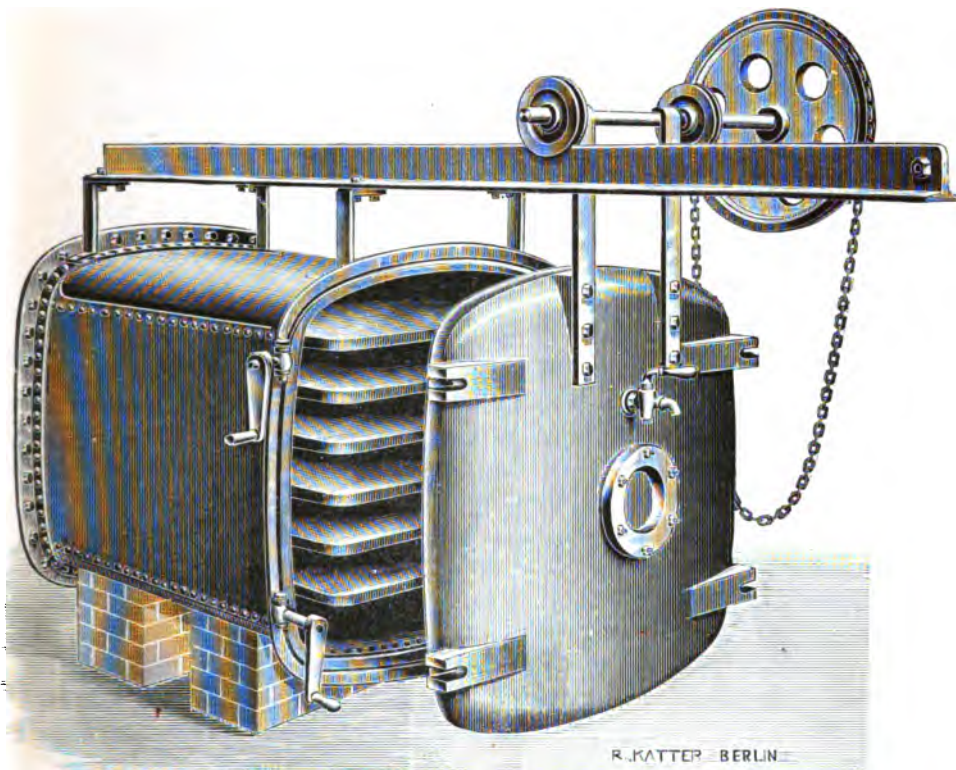


FIG. 73.—VACUUM DESICCATOR

Calcination consists in subjecting a substance to intense heat, with the object of driving off volatile constituents, as the burning of chalk in kilns. In this instance the chalk loses carbon dioxide, calcium oxide remaining in the kiln. Another well-known example of the application of calcination is the pharmacopœial process for the manufacture of heavy and light magnesia from the carbonate.

Sublimation is a purification process. It can only be used for substances that are not injured or decomposed by exposure to heat. The principles involved are (a) vaporisation, (b) condensation.

The substance is converted by heat into the gaseous state, and the vapours are then condensed in a cool chamber or vessel—i.e., it is distilled. Under these conditions the 'sublimate' is generally crystalline.

The chief sublimates of pharmaceutical interest are ammonium carbonate and chloride, arsenious acid, benzoic acid, camphor, mercurous and mercuric chlorides, and sulphur.

An experiment for the sublimation of benzoic acid may be conducted as follows: Benzoin in coarse powder is mixed with dry sand and spread evenly over the bottom of an iron dish, which is then covered with coarse filter-paper pasted round the rim to prevent loss. A conical cap of stiff glazed paper is then fitted closely over the rim, and heat applied by means of a sand-bath until vapours cease to rise. Most of the benzoic acid passes over about 150°C. , but towards the end of the operation the temperature may be increased to 200°C. Even then all the benzoic acid is not sublimed, and a further quantity may be obtained by allowing the dish to cool, breaking up the fused mass into small pieces, and again subliming through a fresh piece of filter-paper. The foregoing yields a product having a pleasant odour, and very different from that obtained artificially. Artificial benzoic acid is generally prepared by chlorinating toluol, and heating the compound formed (trichlormethyl-benzene) with water under pressure, when it splits up into benzoic and hydrochloric acids: $\text{C}_6\text{H}_5\text{CCl}_3 + 2\text{H}_2\text{O} = \text{C}_6\text{H}_5\text{COOH} + 3\text{HCl}$. Large quantities are also made by oxidising naphthalin with nitric acid, and converting the phthalic acid thus obtained into the calcium salt, which latter on being heated yields calcium carbonate and benzoate. From the latter benzoic acid is liberated in the usual way by treatment with a suitable acid.

Camphor is easily sublimed from a copper retort provided with a short wide neck, which is luted into a hole cut in the side of a large wooden box lined inside with glazed paper. The vapours, if the temperature has been properly managed, will condense as a beautiful white powder, easily concreting under pressure. Care must be taken that the vapours do not come into contact with a naked flame, as camphor is extremely inflammable.

Of the other sublimates mentioned, some are obtained as by-products, others being manufactured on an enormous scale for use in the arts, and suitable text-books should be consulted for information concerning them.

CHAPTER VI

COMMINUTION

Under the head of Comminution (Latin *minus*, less) is included the reduction of drugs and chemicals to small particles by mechanical means. All substances to be comminuted should be freed from moisture by drying at suitable temperatures (see Desiccation). Small quantities of crystalline salts and neutral principles may be powdered



FIG. 74.—LARGE GRANITE MORTAR.



FIG. 75.—ROOT CUTTER.

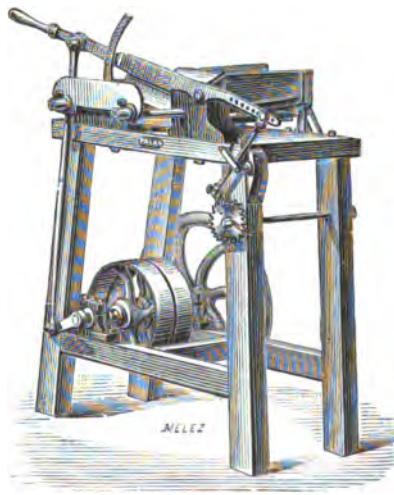


FIG. 76.—AUTOMATIC ROOT CUTTER.

in an ordinary Wedgwood-ware mortar. Larger quantities may be dealt with in marble or granite mortars; the pestles for these mortars (fig. 74) are provided with long shafts for use with both hands, so that considerable pressure may be exerted. Mortars of the size

illustrated should be secured on solid supports on the ground-floor to prevent jarring.

Tough and fibrous plant structures may be sliced with a root cutter (fig. 75) before drying. Fig. 76 shows an automatic root cutter, which may be worked either by hand or by power. The material is placed on an inclined plane, down which it slides to the cutting blades, the length being regulated by a stop plate, which can be altered at will. The sliced material after drying is often bruised in metal mortars provided with heavy iron pestles or beaters, the operation being known as *contusion*. To lessen the labour when

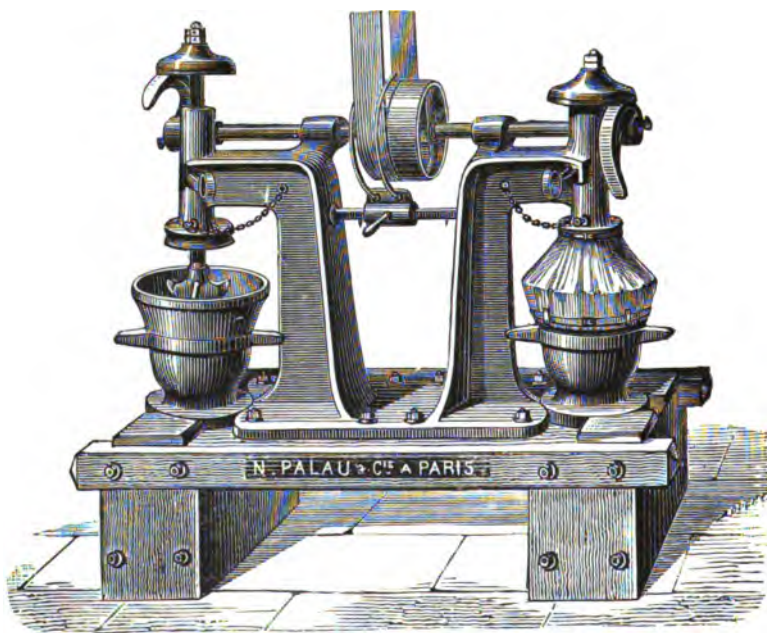


FIG. 77.—MECHANICAL CRUSHERS.

worked by hand the pestle may be suspended from the ceiling, or from a beam, by two or three of the strong rubber springs used for closing

doors, the free ends being fixed at such a height that when hanging loosely the lower end of the pestle reaches to within about six inches of the bottom of the mortar. Fig. 77 illustrates a special form of mechanical crusher worked by power. The pestles are of peculiar shape, and are

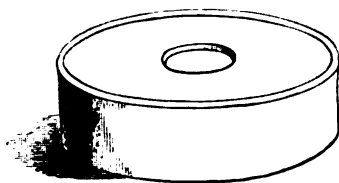


FIG. 78.—MORTAR COVER.

raised by a cam at each revolution of the spindle. To prevent loss due to the fine particles being blown away during powdering, the mortar

is covered by a circular piece of wood, with a hole in the centre for the pestle, and provided with a broad wooden flange, as fig. 78.

The chief means employed by pharmacists as well as by drug-millers for reducing fibrous drugs to powder is by grinding. Fig. 79 shows

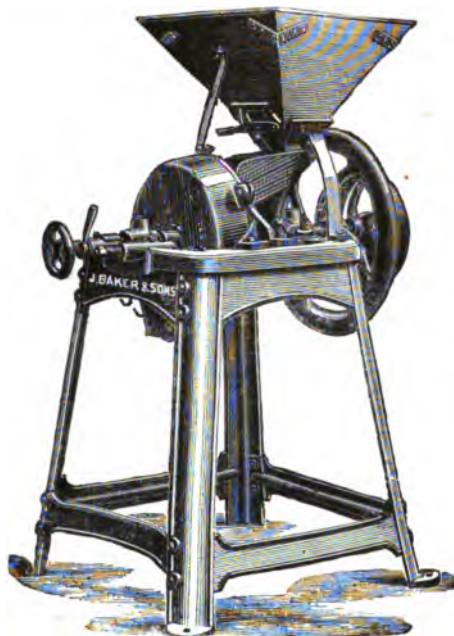


FIG. 79. —METAL DISC MILL.

a metal disc mill well adapted for general work ; the cutting plates are of chilled iron, and are provided with a pair of spiral springs which allow nails or other hard substances to drop through without stopping the mill. The mill is so constructed as to allow a current of air to pass through whilst at work, thereby preventing the material

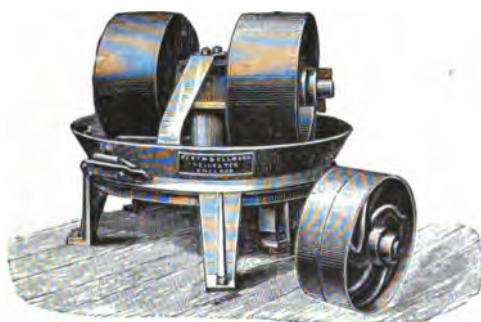


FIG. 80.—EDGE-RUNNER MILL.

from becoming overheated. Fig. 80 shows one of the most useful mills for druggists—viz., the edge-runner mill. In this a pair of stones

revolve inside a shallow iron basin. The material is not only crushed, but actually torn, by the peculiar movement of the stones, each of which revolves on its own axis while both travel round the basin. The material is kept in the path of the stones by suitable arrangements.

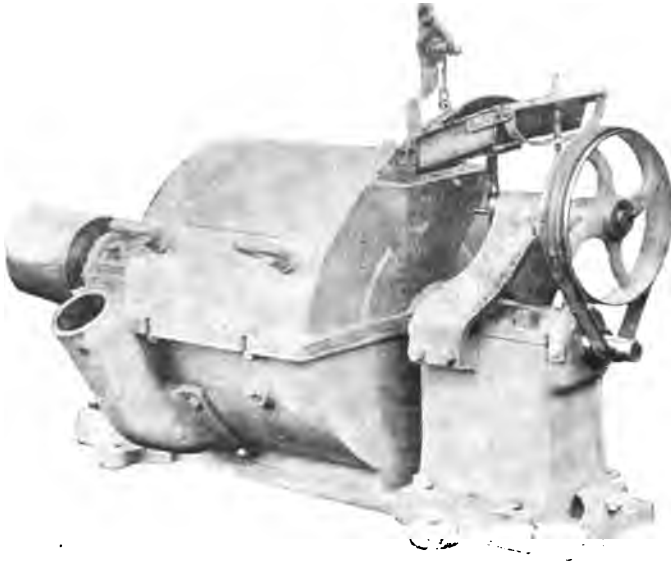


FIG. 81.—DISINTEGRATOR.

Many drugs are nowadays reduced to powder in disintegrators. The material is fed through a hopper into the grinding chamber, where it falls on the extremities of the beaters, which make from one to three thousand revolutions a minute. These strike it forcibly and

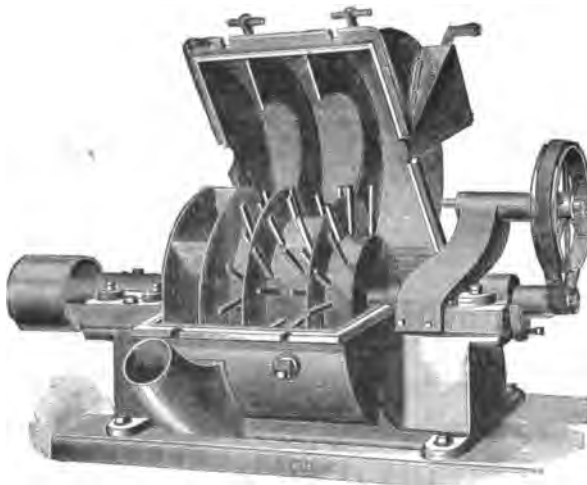


FIG. 82.—DISINTEGRATOR (open).

beat it against the serrated chilled-iron lining of the chamber. Figs. 81 and 82 illustrate one of these disintegrators. Considerable power is required to drive these machines, as they only act properly when worked at very high speeds. Ordinary frictional grinding mills such as the American and Universal, operating with two corrugated-iron surfaces, require these surfaces to be set close together in order to produce fine powders; the friction then set up soon polishes the sharp iron corrugations, and when this occurs grinding can only be carried on by using great pressure, generating considerable heat and so absorbing enormous power.

For powdering certain classes of drugs, such as euphorbium, etc., French pot-mills (fig. 83) are sometimes used. These, as will be seen



FIG. 83.—FRENCH POT-MILL.

from the illustration, consist of a pot made of heavy boiler steel, without any corners for drugs to lodge in, and provided with a closely fitting cover. The material to be powdered is placed in the pot with a steel ball weighing from ten to thirty pounds, and the lid clamped on. The pot is then turned at a speed of about twenty-five revolutions a minute; when the machine has been running sufficiently long the mill is brought to rest, and after a little interval the lid may be removed and the powdered substance taken out.

Fig. 84 illustrates Gardner's buhr mill as used for grinding soft fibrous drugs and spices. The upper stone is stationary. In the illustration the stone on the left hand is raised for the purpose of dressing. The material to be operated upon is fed in through the hopper, and finds its way on to the lower stone, which grinds it against

the upper stationary stone. The two stones almost touch at their periphery, and the material cannot escape until it has been reduced to the required degree of fineness.

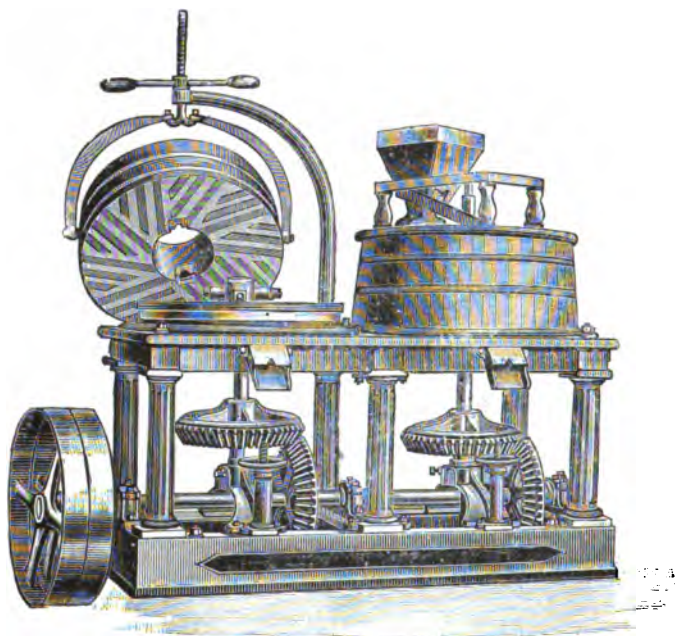


FIG. 84.—BUHR MILL.

Milburn's 'conoidal' buhr-stone mill (fig. 85) has perhaps the simplest construction of any stone mill adapted for pharmaceutical grinding; it is comparatively cheap, and does not require skilled labour to dress the stones. It is fitted with a lever arrangement for automatically relieving the stones from nails and other obstructions likely to injure the mill. As will be gathered from the name, this mill is cone-shaped; the upper stone is a hollow cone fixed inside a cover, inside which the lower furrowed cone, which is attached to a spindle, works. The space between the faces increases towards the top, where the material to be ground is introduced through a hopper—the stones only approaching one another closely from one to two inches from the bottom. It is evident from this arrangement that no material can escape from between the stones until it has acquired a minimum grade of fineness, the degree of which is regulated by the closeness with which the stones approach at their bases. When the stones become too smooth from long use they only require roughening with a mill-bill, which is easily done after loosening the wing nuts and removing the cover attached to the fixed stone.

Sieves.—Although in milling the material is apparently subjected to an equal amount of grinding and bruising, yet all the particles are

not of the same degree of fineness, therefore to obtain the powder in a nearly uniform state of disintegration it is passed through a sieve of a particular mesh. The degrees of comminution are represented by numbers ranging from 12 to 180. These indicate the numbers of parallel wires of a definite gauge within a linear inch forming the meshes of the sieves used. Thus a No. 30 sieve contains thirty wires in a linear inch, or 900 holes in a square inch. Ingredients required for infusion, etc., are reckoned sufficiently fine if passed through a very coarse sieve, while powdered rhubarb, for example, is generally passed through a No. 120 sieve; an extreme example is seen in powdered boric acid, which, for many pharmaceutical purposes, is ground until it can be shaken through bolting cloth having about 170 threads in a linear inch. The question of sieves is again referred to in the chapter on Powders.

The first operation connected with the grinding of drugs consists in drying them. If in large masses, they are cut or broken into small pieces to facilitate the drying, and also to prepare them for the final grinding. When thoroughly dry, the substance is either powdered in a mortar or ground in a mill, the powder being sifted from time to time, and the residue which does not pass through the sieve returned to the mill for further treatment; this method of alternately grinding and sifting is continued until the process is finished. The facility with which drugs may be reduced to powder depends upon the care bestowed on their previous drying. If the latter operation has been incompletely carried out, it will be impossible to produce fine powders. Some drugs, such as squill, absorb moisture again so rapidly that it becomes necessary to return them to the drying-room before the operation can be completed.

Certain drugs, no matter how carefully the drying operation has been conducted, can scarcely be reduced to powder by the ordinary methods. *Nux vomica* and *St. Ignatius* beans belong to this class.

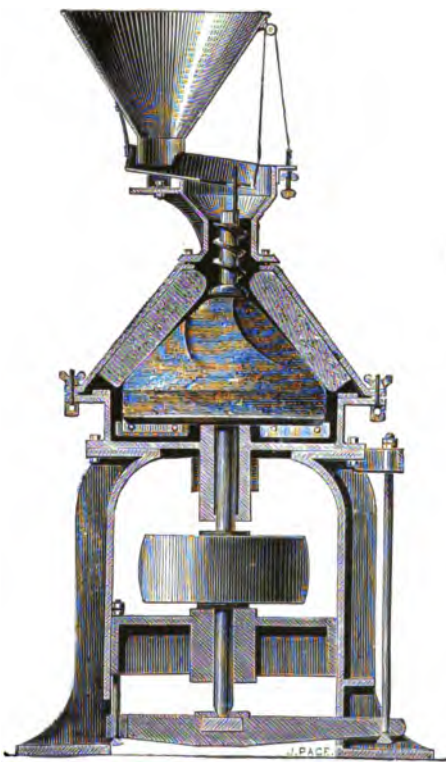


FIG. 85.—CONOIDAL BUHR MILL (section).

These tough and horny seeds are first exposed to the action of steam. Other substances which require a little management in powdering are camphor, spermaceti, shellac, etc. Camphor is readily powdered by the aid of a few drops of rectified spirit; spermaceti by the help of a trace of oil. Shellac is powdered fairly easily, but not so easily sifted, and to assist the latter operation the powder is slightly wetted with water before being rubbed through the sieve.

All substances which contain volatile principles lose a portion during the process of drying and powdering, and, if the efficacy of the substance depends upon these principles, the drying must be conducted at as low a temperature as possible. Thus myrrh, cardamoms, cinnamon, etc., lose aroma, while other drugs, as rhubarb, scammony, ipecacuanha, etc., may be dried at a fairly high temperature without impairing their activity.

When a parcel of drug has been ground and sifted, it does not necessarily follow that the whole powder is in a state of uniformity. Far from this being the case, it is found by experience that the medicinal activity of the powder varies greatly, the last portion, or *gruffs*, containing only a trace of the active principles, while the first sifting may contain an undue proportion. To remedy this, the whole batch of powder must be again mixed and passed through the sieve.

Levigation (Latin *levis*, smooth, and *ago*, I make) is the operation of reducing substances to an impalpable or very fine powder while in a moist condition. Originally this process was often carried out on a porphyry slab, the moistened material being ground beneath a large flat stone (fig. 86) held with both hands. This stone is called a *muller*, and considerable dexterity is required to use it properly. During the operation a circular motion is given to the sweep of the muller, gradually diminishing circles being intersected with figures of 8. The pasty substance should be constantly scraped off the edges of the muller and extremities of the slab, and spread in the path of the stone. This process is eminently adapted for the reduction to a fine powder of such substances as red oxide of mercury. On a large scale the operation is carried out in mills.

Elutriation (Latin *e*, and *luo*, I wash) is the name given to the operation of separating the coarse from the fine particles of an insoluble powder by suspension in water and partial subsidence. Elutriation frequently follows the process of levigation. The material, whether in a pasty or dry condition, is thoroughly agitated with a considerable bulk of water, and set aside to deposit. After a time, depending upon coarseness and relative gravity, the heavier particles will subside; the upper layer, containing the finer and lighter particles still in suspension, is then carefully decanted and again set aside to deposit. If desired, the coarse particles are again subjected to

levigation, and again elutriated until the whole is brought to a state of fine division, when the mixed deposits are collected, dried, and sifted.

The process of elutriation is made use of in the preparation of calamine, chalk, etc. The little conical masses in which prepared chalk comes into the market are formed by placing the pasty sub-

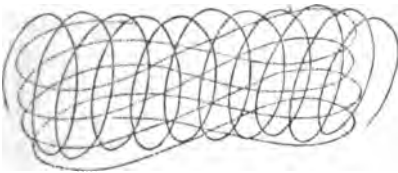
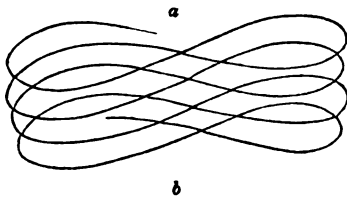
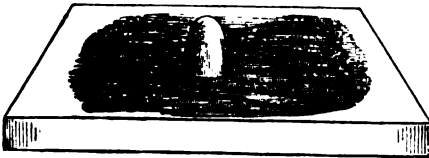


FIG. 86.—SLAB AND MULLER.



FIG. 87.

stances in a funnel fixed in a wooden handle, to which is attached a short peg, as fig. 87. The apparatus is then gently tapped on a slab of chalk or on other porous substance; each tap causes a conical mass to fall out. The porous block absorbs the moisture before the cones have time to lose their shape.

CHAPTER VII

EXTRACTION

The chief methods employed for extracting the active principles of drugs are decoction, infusion, maceration, and percolation.

Decoction is the process employed for dissolving out the active principles of drugs by *boiling with water*. (See Decoctions.)

Infusion is the process employed for dissolving out extractive matter from vegetable tissues by steeping in water. (See Infusions.)

Maceration consists in steeping material at the ordinary temperature in an alcoholic liquid for a definite period, agitating at intervals. The liquid is then strained off, the exhausted drug strongly expressed, and the liquids mixed and filtered. Examples of its application are seen in the preparation of many tinctures.

Percolation.—In the majority of instances percolation is considered the most perfect method for obtaining the active principles of drugs in solution. Briefly, it consists in allowing a liquid (the *menstruum*) to trickle slowly through a column of the material in such a way that every solid particle is in turn submitted to the solvent action of the gravitating fluid. Its applications in pharmacy are numerous.

Repercolation is a modification of the foregoing, the difference being that instead of submitting the whole of the material to the action of the menstruum at once, it is divided into two, three, or more equal portions and packed in percolators. The menstruum having been poured on the *first* portion, percolation is allowed to proceed until percolate collects in the receiver. This percolate is then poured on the drug contained in the *second* percolator, and the percolate from this used to exhaust the contents of the *third* percolator. This process is continued, every fresh addition of menstruum being made to pass through each percolator in turn until the drug is exhausted or a sufficiency of strong percolate is collected. By this means a small volume of liquid may be made to exhaust a comparatively large amount of material, doing away, in many instances, with the necessity for concentration at the end of the process. A good example of the application of repercolation is seen in the preparation of liquid extract of belladonna.

The liquid remaining in the marc may be recovered by pressure

and used to exhaust the next batch, instead of taking fresh menstruum.

Pressure maceration.—This term may be applied to a process sometimes employed for exhausting certain drugs with a minimum quantity of menstruum, and is exemplified in the official process for syrup of senna. Senna leaves are moistened with 20-per-cent. alcohol, and pressed tightly in a press-box. As a rule very little liquor comes away; a further small quantity of menstruum having been poured on, the pressure is somewhat relaxed, with the result that the fluid is instantly sucked up. After macerating for a short time, the pressure is increased and the liquor forced out; fresh menstruum then being added, pressure is once more relieved, and this process of successively sucking up liquid, macerating, and pressing-out continued, until the marc is exhausted or a sufficient quantity of liquid extract is obtained. Operating on the pharmacopœial quantities the densities of the expressed liquids obtained were :

1st expression	.	.	.	.	sp. gr. 1·068
2nd „	.	.	.	.	„ 1·035
3rd „	.	.	.	.	„ 1·013

As the specific gravity of 20-per-cent. alcohol is 0·976, it appears that the last expression contained but little extractive, consequently it was useless to continue the extraction.

PERCOLATION

Percolation (Latin *per*, and *colo*, I strain).—The process of percolation consists in subjecting a substance, or substances, in more or less fine powder, contained in a vessel called a percolator, to the solvent action of successive portions of *menstruum*, in such a manner that the liquid as it traverses the powder in its descent to the receiver shall be charged with the soluble portion of it, and pass from the percolator free from insoluble matter. When the process is successfully conducted the first portion of the liquid or *percolate* passing will be nearly saturated with the soluble constituents of the substance treated; and, if the quantity of menstruum be sufficient for its exhaustion, the last portion will be destitute of colour, odour, and taste, other than those possessed by the menstruum itself. The exhausted material is generally referred to as the *marc*.

The Pharmacopœia directs percolation to be carried out as follows : After moistening the solid material with the prescribed quantity of menstruum, it is set aside in a closed vessel for twenty-four hours to swell. The mixture is then packed, lightly or closely according to the nature of the materials, in a percolator, and the menstruum poured on, care being taken that a layer of liquid is maintained above the

level of the material. Percolation is then allowed to proceed slowly until three-quarters of the finished preparation has been collected, or until the solid material has been exhausted. The marc is then removed from the percolator and submitted to pressure, the expressed liquid filtered and mixed with the percolate, and sufficient menstruum added to produce the prescribed volume.

The details and minor variations of the process are left to the judgment of the pharmacist, the only recommendation being the use of a glass or earthenware percolator of such dimensions that a column of solid material at least six times as high as wide is presented to the menstruum. The shape of the percolator may be

either cylindrical or conical; if the latter, the lower diameter of the percolator should be not less than half that of the upper.

The percolator most suitable for the quantities contemplated by the Pharmacopœia should be nearly cylindrical or slightly conical, with a funnel-shaped termination at the smaller end (fig. 88). The neck of this funnel-shaped termination should be rather short, and should gradually and regularly become narrower towards the orifice, so that a perforated cork bearing a short glass tube may be tightly wedged into it from within, and the end of the cork is flush with the outer end of the orifice. The glass tube, which must not project above the inner surface of the cork, should extend about an

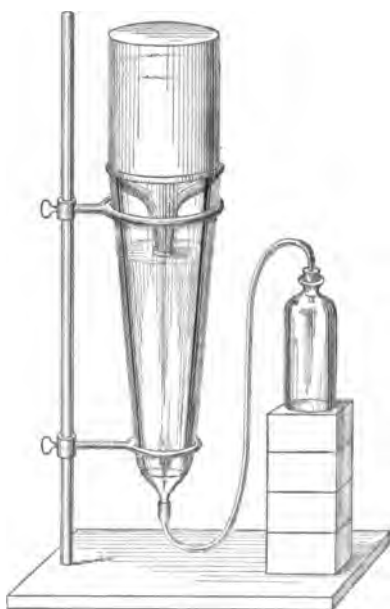


FIG. 88.—PERCOLATION.

inch and a half beyond the outer surface of the cork, and should be provided with a closely fitting rubber tube at least one-fourth longer than the percolator itself, and ending in another short glass tube, whereby the rubber tube may be so arranged that its orifice shall be above the surface of the menstruum in the percolator, a rubber band holding it in position.

The percolator should be adapted to the nature of the drug to be operated upon; for drugs which are apt to swell, particularly when a feebly alcoholic or an aqueous menstruum is employed, a *conical* percolator is preferable. A *cylindrical* or only slightly tapering percolator may be used for drugs which are not liable to swell, or when the menstruum is strongly alcoholic, or when ether or some other

volatile liquid is used for extraction. The size of the percolator selected should be in proportion to the quantity of drug to be extracted. When properly packed in the percolator, the drug should not occupy more than two-thirds of its height. The percolator, unless otherwise directed, may be made of any suitable material not affected by the drug or menstruum.

A tuft of cotton is sometimes directed to be placed in the neck of the percolator above the cork. The objection to cotton is that, when wetted and under pressure, it becomes impacted, the liquid refusing to filter through it. Glass wool is better for the purpose, retaining its spongy condition even under considerable pressure. 'Slag wool' is equally good, and is much cheaper, the price per pound being less than the price per ounce of glass wool. It is commonly used as a packing to retain the heat of steam boilers and pipes. Sometimes the slag wool contains a number of glassy beads. If desired, these may be got rid of by washing the wool in a large volume of water, when the beads sink to the bottom. Asbestos has been recommended, but it has no advantage over slag wool, and is much more expensive.

The powdered substance to be percolated (which must be uniformly of the fineness directed in the formula, and should be perfectly air-dry before it is weighed) is put into a basin, the specified quantity of menstruum poured on, and the whole thoroughly stirred with a spatula or other suitable instrument until the drug appears uniformly moistened. The moist powder is passed through a coarse sieve and poured into the percolator. It is then shaken down lightly, and allowed to remain for a period varying from fifteen minutes to several hours; after which the powder is pressed, by the aid of a plunger of suitable dimensions, more or less firmly in proportion to the character of the powdered substance and the alcoholic strength of the menstruum—strong alcoholic menstrea as a rule permitting firmer packing of the powder than the weaker menstrea. The percolator is now placed in position, and, the rubber tube having been fastened at a suitable height, the surface of the powder is covered by an accurately fitting disc of filter-paper or other suitable material, and a sufficient quantity of the menstruum poured on through a funnel reaching nearly to the surface of the paper. If the conditions have been observed, the menstruum will penetrate the powder equally until it has passed into the rubber tube, and has reached in this a height corresponding to its level in the percolator. The apparatus is now closely covered to prevent loss by evaporation, and allowed to stand at rest for some time. To begin percolation the rubber tube is lowered, and its end introduced into the neck of a bottle previously marked with the quantity of liquid to be percolated if the percolate is to be measured, or of a tared bottle if the percolate is to be weighed. By raising or lowering the receiver the rapidity of percolation may be retarded or

accelerated, care being taken, however, that the rate of percolation, unless the quantity of material is largely in excess of the pharmacopoeial quantity, shall not exceed the limits of ten to thirty drops in a minute. (The rate or speed of percolation may be increased in proportion to the amount of drug percolated.) A layer of menstruum must be constantly maintained above the powder so as to prevent access of air to the interstices until the fluid has all been added, or the requisite quantity of percolate has been obtained. This is conveniently accomplished, if the space above the powder will admit of it, by inverting a bottle containing the entire quantity of menstruum over the percolator, in such a manner that its mouth dips beneath the surface of the liquid, the bottle being of such shape that the shoulder serves as a cover for the percolator.

The object in moistening the drug is to allow it to swell before being packed in the percolator, thus avoiding blocking. In nine cases out of ten, if the drug were packed in a dry state, or even before its tissues had fully expanded from the imbibition of moisture, percolation would proceed very slowly, or perhaps with some drugs would cease altogether. Too much care cannot be exercised in packing the material evenly, and for this purpose a plunger of relatively large size should be used. If unevenly packed the menstruum will select the course that offers least resistance, the more tightly packed portions being almost unaffected by the solvent. If a glass percolator is used, the descent of the menstruum can be watched. The reason so much stress is laid upon the necessity for keeping a layer of liquid above the surface of the solid material is that, if allowed to run dry, air enters and fills the interstices, and, if left long enough, cracks and channels are formed, down which the menstruum trickles without coming into contact with the bulk of material at all. The degree of fineness to which the material should be reduced varies greatly. Drugs of a loose spongy nature, such as gentian or rhubarb, need not be passed through a finer sieve than No. 30; while others of a horny nature, such as the seeds of *nux vomica*, are required to be in the very finest powder to ensure complete exhaustion. Again, the degree of firmness with which a drug may be safely packed depends largely upon the character of the menstruum to be used. If the latter be only feebly alcoholic, and especially if it happen to consist of water only, the packing must be much more lightly done than if the liquid consisted of strong alcohol or other volatile solvent. The nature of the menstruum also influences the shape of the percolator to be selected. If an aqueous menstruum is used, the percolator should be distinctly conical to allow of the lateral and vertical expansion of the material as its tissues become saturated. If, on the other hand, the menstruum is strongly alcoholic, a cylindrical percolator is to be preferred, as a longer column of material may be exposed to the solvent without risk of clogging.

Recovery of spirit from marcs.—After exhausting and pressing, the material may still contain considerable quantities of spirit. All residues should therefore be retained and stored in a stone jar with a closely fitting bung for future treatment. The usual method of dealing with marcs when a sufficient quantity has accumulated is to place them in a still with a considerable volume of water, and distil as long as any alcohol comes over in the distillate, which may afterwards be concentrated by re-distillation and purified in the usual way. In the 'Year-book of Pharmacy' for 1895, Bird describes an inexpensive apparatus for the recovery of the alcohol from tincture marc without addition of water, thus saving subsequent re-distillation. The details will be readily apparent from the sectional sketch (fig. 89). The lower part of the apparatus forms the water-bath; it is of large area and very shallow, and is furnished with a side tube for a thermometer. The condensing cover is a circular water-tank having the bottom dished up into a cone, the edge of which terminates in a V-shaped trough round the inner edge of the water-bath. This trough is cooled by a cold-water jacket underneath, and is inclined

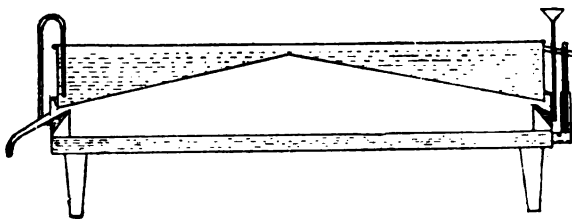


FIG. 89.—APPARATUS FOR RECOVERING ALCOHOL FROM MARCS.

so that all liquid runs out by the tube leading from it. The water-pipes are so arranged that a current of cold water passes first round the water-jacket of the collecting trough, and then into the condensing cover which rests on a flange in the water-bath. The joint is secured by luting. It will be noticed that the condensing surface is very near the material from which alcohol is to be recovered, and the whole construction of large area and shallow, the dimensions being—diameter 18 inches, depth of water-bath 2 inches, height of cone in centre 2 inches. The marc having been spread evenly over the bottom of the water-bath, the condensing cover luted on, and a small stream of cold water turned into the apparatus, the application of heat is quickly followed by the condensation of spirit. This takes place at a comparatively low temperature. When dealing with a proof-spirit marc, for instance, a fairly rapid succession of drops falls from the delivery tube at 27° C., and at 60° C. the greater part of the spirit may be recovered.

Upward displacement by water is also occasionally resorted to for the recovery of the alcohol. Although theoretically water should easily displace spirit in a spongy material, yet owing to the difference

in gravity, it is found by experiment that results vary considerably, much alcohol being wasted owing to the two liquids mixing.

Various forms of percolating apparatus.—When working with small quantities of material glass percolators are desirable; these may be cylindrical, as fig. 90, or conical, as figs. 91, 92, and 93. Perhaps



FIG. 90.—CYLINDRICAL PERCOLATOR.



FIG. 91.—CONICAL PERCOLATOR.

one of the most useful of its kind, and one of the most largely used by retail pharmacists in this country, is the York Glass Co.'s percolator (fig. 93). Their original form consisted of two glass vessels fitted together, as shown in fig. 92. The lower vessel, or receiver, had two openings—a wide one for the ground neck of the percolator, and a narrow one for the escape of the displaced air, which passed up a flexible tube into the perforated stopper. In the present form the flexible air-tube has been done away with, the escape and entrance of air being provided for by an ingenious arrangement of grooves cut in the fitting parts, and for convenience in drawing off the percolate a glass tap is fitted to the receiver. The groove in the stopper extends a little more than halfway down the ground surface; that in the corresponding upper part of the percolator extends for the same length upwards; consequently when the two grooves are in line a small air-passage is formed, but when the stopper is turned either to the right or to the left the grooves do not affect the air-tight character of the stoppering. The grooves in the other fitting surfaces are precisely similar to those just described. Fig. 93 shows the groove of the stopper in such a position as effectually to prevent escape or entrance of air, that of the lower junction arranged so as to allow the displaced air to escape from the receiver. It will be obvious that when each pair of grooves is in a straight line percolation will proceed freely, as air will pass into the percolator and out of the receiver, whereas if the grooves are turned out of line percolation will cease.

If, therefore, all the joints are made air-tight, maceration of the solid substance goes on, but no percolation takes place.

For the preparation of very small quantities of tinctures by percolation, excellent percolators may be made by cutting the bottoms off champagne bottles. This is an operation requiring some little skill. One method is to file a deep notch on the side of the bottle about an inch from the bottom, and then lead a crack in the required direction by a red-hot nail. An easier and quicker method, which is

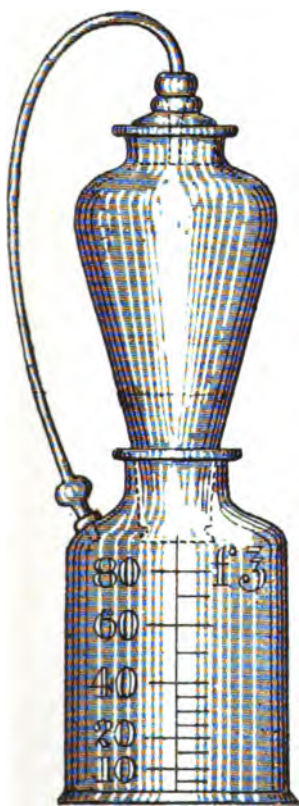


FIG. 92.

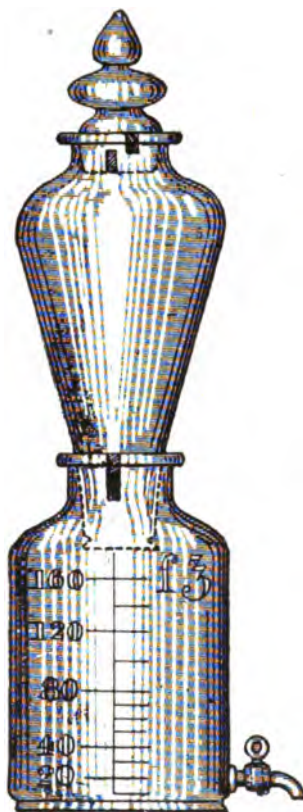


FIG. 93.—YORK GLASS CO.'S PERCOLATOR.

frequently successful, is to stand the perfectly dry bottle on a very hot sand-bath for about a minute, remove it, and before the heat has time to spread, rapidly pour in a little cold water by means of a funnel reaching nearly to the bottom. As a general rule, the bottom of the bottle comes away quite cleanly; the secret of success consists in making the bottom of the bottle very hot, and in pouring the water taking care that none splashes against the sides. The sharp edge is then ground smooth on a sheet of glass with emery and water.

To prevent loss by evaporation when a very volatile menstruum is employed, a stoppered glass percolator of the form shown in fig. 93

may be used, or if large quantities are under operation a tinned-copper percolator with a cover fitting into a water or mercury seal, as fig. 94. The method of construction is easily seen from the diagram,

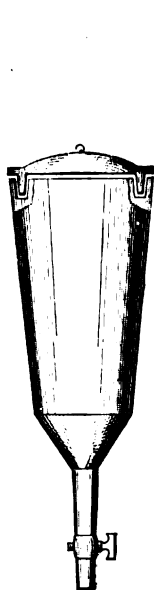


FIG. 94.—PERCOLATOR WITH WATER-SEAL COVER.

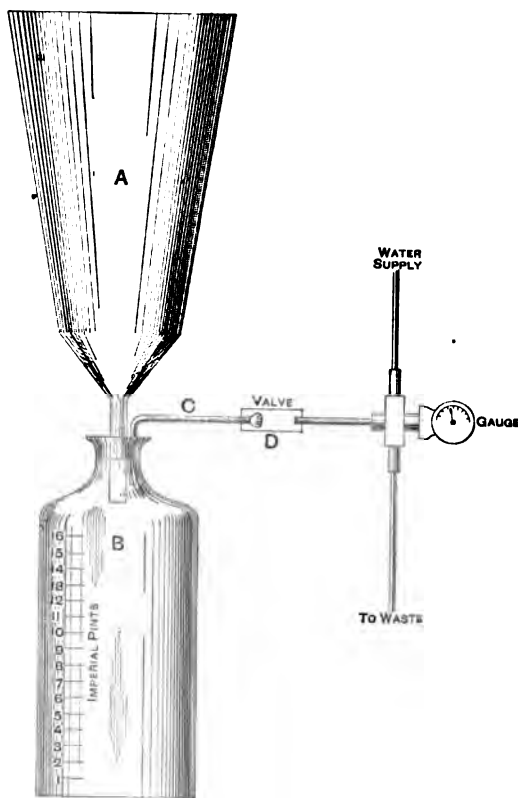


FIG. 95.—PERCOLATOR CONNECTED TO WATER-PUMP.

the apparatus consisting of an ordinary conical or cylindrical percolator, with a hollow rim at the top containing either mercury or water, into which the loosely fitting flanged cover drops.

Percolation under pressure.—It occasionally happens that a substance has to be exhausted by percolation, which, no matter the precautions taken in grinding, moistening, and packing, becomes so impacted as to delay unreasonably or altogether stop the process. Recourse is then had to pressure-percolation. It is obvious that, if the pressure exerted upon the surface of the liquid in the percolator be increased, the liquid will be forced to percolate through the material at a greater rate. The pressure may be increased in several ways, the most simple being to increase the height of the column of menstruum above the surface of the material. When the volume of liquid is insufficient for this purpose the air pressure may be increased. There are two ways of doing this : either by exhausting the air from

the receiver by a pump, or by forcing air under pressure into the upper portion of a percolator provided with an air-tight lid.

Fig. 95 shows an apparatus in which a water-pump is employed for creating the vacuum. A is an ordinary glass percolator, B the receiver. The receiver is fitted with a good bung pierced with two holes. The exit tube from A passes through one of the holes, while a piece of glass tubing (c), of about one-eighth of an inch or less bore, is inserted in the second. The joints are made tight by painting with strong gelatin solution containing 5 per cent. of glycerin. The glass tube (c) is connected by pressure tubing to a Korting's or Geissler's filter-pump. As soon as water runs through the pump, air is drawn out of the receiver, the percolate in most cases beginning to drop at once. With a Korting's pump an almost complete vacuum can be maintained for any length of time, provided the joints remain tight. If the receiver is of thin glass, it is not advisable to create a vacuum sustaining more than ten to fifteen inches of mercury, otherwise there is considerable danger of the vessel collapsing under the atmospheric pressure. A glass valve must be inserted between the receiver and the pump, as shown at D, to prevent any possibility of water from the tap being sucked back into the receiver, should the pressure in the main be lowered from any cause. To construct the valve, take a short length of glass tubing of fairly wide bore, and fit with rubber plugs. Through one pass a narrow glass tube and connect to the filter-pump; through the other pass a similar tube, but tie over one end an infant's feeding-bottle teat pierced with leech-bites, and connect the other end to the receiver. As soon as the pump is started a partial vacuum is formed and air drawn through; but should the pressure at the pump fall, no water can be drawn into the receiver on account of the cuts in the teat being pressed tightly together.

If a constant supply of water is not available to work a filter-pump, a partial vacuum may be obtained by the aid of an aspirator arranged as fig. 96. The upper cylinder is filled with water and the air-tube connected with the receiver. As soon as the water is allowed to flow into the lower cylinder a partial vacuum is created in the upper one, and air is sucked in from the receiver.

Fig. 97 shows a simple pressure percolator, which can be fitted up at small cost. A is an ordinary tinned-copper percolator with a broad flange at the top instead of the usual rounded rim; the lid (E) has a corresponding flange, and is held in place by four strong clamps (D), a soft rubber washer between the two metal surfaces serving to make the joint air-tight. An ordinary pneumatic-tyre valve is soldered into the lid at B, and, if desired, a cycle pressure gauge at C. All that now remains to be done is to screw a cycle pump on the valve (B), and force air into the upper part of the percolator until the desired pressure is attained.

The receiver of a percolator may be of any convenient shape or dimensions, but should preferably be made of glass. All receivers should, however, be accurately graduated, either temporarily with a paper mark, or permanently with a diamond or hydrofluoric acid.

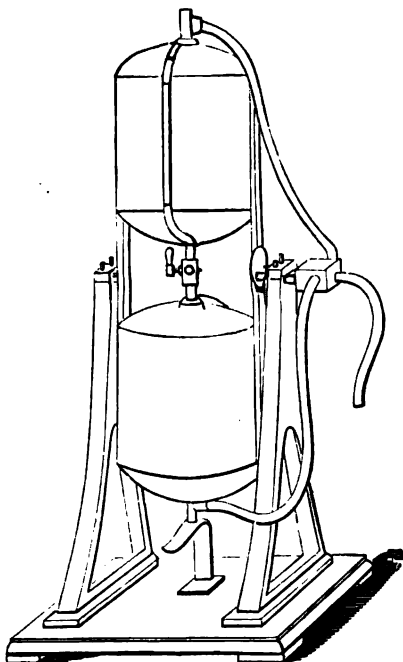


FIG. 96.—DOUBLE REVERSIBLE ASPIRATOR
IN FRAME FOR CONTINUOUS USE.

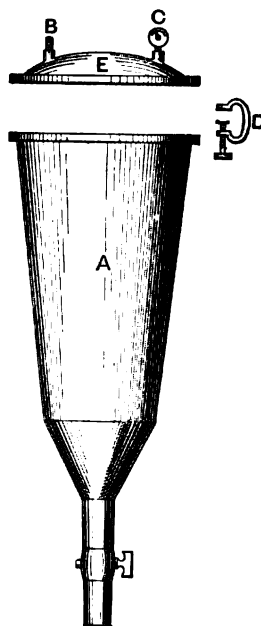


FIG. 97.—PRESSURE PERCOLATOR.

Exhaustion.—Many drugs are directed to be percolated until exhausted. Absence of colour in the percolate is no indication, as the active principles of many substances are extracted long before the percolate becomes colourless. In the case of drugs possessing a markedly bitter taste, as *casarea* and *quassia*, exhaustion is indicated by the absence of bitterness. Alkaloidal drugs may be considered exhausted when the percolate no longer turns cloudy on the addition of Thresh's or Mayer's reagent. The Pharmacopœia directs *cinchona* to be percolated until the percolate no longer yields a precipitate with ammonia.

NOTE.—As an illustration of the process of percolation, one pint of compound tincture of rhubarb was started, and the percolate collected in fractions of four fluid ounces. The ingredients were first macerated for forty-eight hours; afterwards, twenty-four hours' maceration was allowed between the fractions:

1st fraction was very dark coloured	sp. gr. 0.986
2nd fraction, still dark coloured	" 0.931
3rd fraction, much lighter in colour	" 0.918
4th fraction (of six ounces) nearly colourless	" 0.915
The menstruum (60-per-cent. alcohol)	" 0.913

CHAPTER VIII

EXPRESSION

Many pharmaceutical operations require the removal of small quantities of liquids from relatively large bulks of solid material. When this cannot be accomplished by filtration (*q.v.*) the moist material is squeezed in a machine called a press, and the liquid forcibly expelled. This is termed *expression*. When working on small quantities screw presses are generally used, while for very large quantities, or when great pressure is required, hydraulic presses are employed.

In all operations requiring the use of a press, the pressure should be increased very slowly; after a time, as the liquid drains away, more force may be used until, as the material becomes dry, it may be squeezed as strongly as possible without rupturing the press-cloth.

Screw presses.—Fig. 98 shows a double-action tincture press. After the material (which has been wrapped in a cloth) has been placed in position the plunger is screwed down as far as it will go by the vertical screw; greater pressure is then exerted by the worm-and-wheel action.

The hydraulic press is the most powerful of all presses. Its action depends on the application of the law of the equality of pressures.

Pressure exerted anywhere on a mass of liquid is transmitted undiminished in all directions, and acts with the same force on all equal surfaces, in a direction at right angles to those surfaces. An approximate verification of this statement may be effected by taking two cylinders of different diameters and connecting them with



FIG. 98.—DOUBLE-ACTION TINCTURE PRESS.

a tube, the whole being partly filled with water. Each cylinder is provided with a closely fitting piston. Let the area of the larger piston be fifty times that of the smaller. That being assumed, let a two-pound weight be placed upon the small piston. This pressure will be transmitted to the water and to the large piston; and as this pressure amounts to two pounds on each portion of its surface equal to that of the small piston, the large piston must be weighted with one hundred pounds to counterbalance it. It is important to observe that in speaking of the transmission of pressure, it must always be supposed to be perpendicular to the sides of the containing vessel. An ordinary hydraulic press consists of a powerful frame fixed on a base, and having a massive head, which is secured in its place by bolts and nuts. Inside this frame is an iron cylinder containing the ram. The cylinder is connected with a force-pump by a pipe of small bore. The press plates are kept in position by guiding rods. When the pump is set going the water enters the cylinder, and forces the ram upwards in accordance with the law previously stated. The pressure must be increased very gradually to avoid bursting the bags. A safety-valve is fixed at one side of the press to relieve

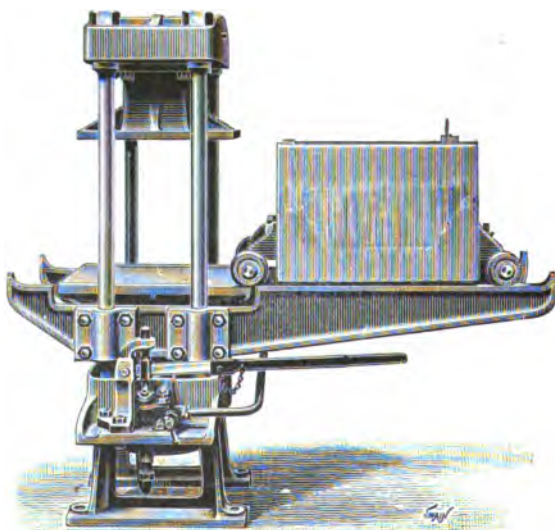


FIG. 99.—MODERN HYDRAULIC PRESS.¹

the pressure on the cylinder should it be over-pumped. Fig. 99 is a convenient form of press for pharmaceutical use. The material is placed in a press-box mounted on wheels, arranged to run out on rails for charging and emptying. The press-box is fluted down its sides, and is fitted with a perforated lining to permit the escape of the expressed liquid.

¹ Bennett, Sons & Shears' patent.

In using the presses described, some means are generally required for confining the material during the process of expression. Frequently the substance may be put directly into the press-box, but many substances require to be enclosed in a press cloth or bag previous to introduction into the press.

Press-bags are very commonly made of horsehair cloth, a material which possesses great strength and durability, yet does not absorb liquids to the same extent as linen or woollen bags. Horsehair bags are, moreover, very readily cleansed. Strong canvas or unbleached linen is sometimes substituted for horsehair, but is inferior in strength, although closer in texture and more flexible. Many substances can be effectively pressed if simply enclosed in the coarse material commonly known as cheese-cloth; but no matter what material is used, the operation can only be conducted successfully by applying the pressure gradually. If the substance is soft and pulpy, the pressure must be exerted very cautiously, as at first it will behave like a liquid, and will refuse to take the pressure. When part of the liquid has been squeezed out the pressure may be increased, until ultimately, as the contents of the bag become nearly solid, the full force of the press may be safely employed.

The pressure exerted by a hydraulic press depends upon the relation of the area of the plunger of the pump to the area of the ram, and upon the proportionate length of arm on either side of the fulcrum. Suppose, for instance, the length of the lever is 30 inches, the distance between the fulcrum and the piston 3 inches, and the power applied equivalent to 100 lb. Then $100 \times \frac{30}{3} = 1000$ lb.; if the area of the ram is fifty times that of the plunger, then the total lifting capacity will be $1000 \times 50 = 50,000$ lb.

CHAPTER IX

FILTRATION

Filtration is the process by which liquids are separated from substances mechanically held in suspension. Various materials are employed as filtering media, the chief being paper, cotton and linen fabrics, woollen cloth (flannel and felt), absorbent cotton, glass-wool, slag-wool, kieselguhr, powdered glass, sand, charcoal, etc.

The simplest application of filtration in pharmacy is the removal of suspended matter from aqueous and alcoholic solutions. This is generally accomplished on the small scale by folding a circular piece of fine *unsized* paper across its diameter, then again at right

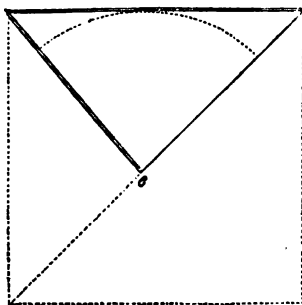


FIG. 100.

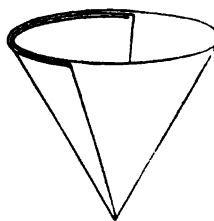


FIG. 101.

angles, and opening it out in the form of a hollow cone (figs. 100 and 101); this is then placed in a funnel and the liquid to be filtered poured gently in, taking care that the stream is directed against the side, and not on the apex of the filter. Frequently, however, filtration proceeds very slowly, owing either to the faulty shape of the funnel, or to the filtering-paper lying too closely against the side. The apex of the funnel should have an angle of sixty degrees, so that circular filter-papers folded as directed fit accurately, as fig. 102.

The funnels supplied by the makers are sometimes ribbed or fluted inside to facilitate the flow of the filtrate. The ribs or flutings, however, are rarely prominent enough. To be of any service they should be in comparatively high relief, as shown in figs. 103 and 104. These funnels are moulded uniformly to the correct angle, and possess

either prominent spirals or deep corrugations, thus offering very few points of contact with the paper, so that filtration is very rapid. It would be an advantage if the funnels were made with a projection on the stem, thus permitting ready escape of the displaced air when filtering into narrow-necked vessels. To prevent splitting the necks of these

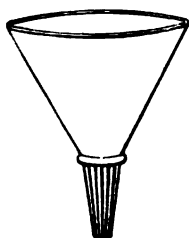


FIG. 102.
PLAIN FUNNEL.

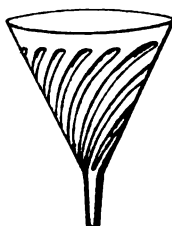


FIG. 103.
FUNNEL SHOWING
SPIRALS.



FIG. 104.
FLUTED FUNNEL.

it is frequently necessary to use funnel supports, as fig. 105. These may be made of either wood or iron, but in either case the foot should be sufficiently massive to afford stability.

Funnels of small size are usually made of glass or earthenware, large sizes of tinned iron or tinned copper. Lately aluminium funnels

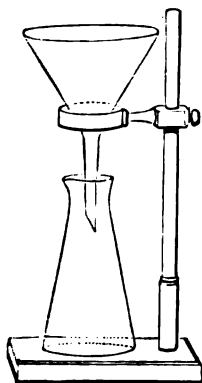


FIG. 105.
FUNNEL SUPPORT.



FIG. 106.
FILTERING RACK.

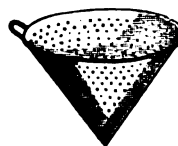


FIG. 107.
ZINC FILTERING CONE

have appeared in the market, and they specially recommend themselves to the pharmacist on account of their lightness. The metal is, however, difficult to work, and as the funnels are generally spun on a lathe, they are neither ribbed nor fluted. Filtration accordingly proceeds slowly unless some device, such as the filtering rack (fig. 106)

or the perforated cone (fig. 107), is adopted to keep the filtering-paper from adhering to the side of the funnel.

The most delicate portion of a paper filter is the apex, and it is here that rupture generally occurs, but support may be obtained from a filtering cone pierced with holes, placed in the throat of the funnel.

Up to now plain paper filters have alone been considered, but on account of the slowness with which they filter, they are rarely used except for collecting a precipitate without regard to the filtrate; in that case the fewer the folds the more easily the precipitate is detached from the paper. Liquids pass through a plaited filter-paper more quickly than through a plain one. The method of folding may be explained by the aid of the following diagrams.

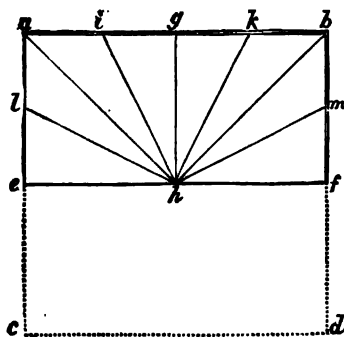


FIG. 108.

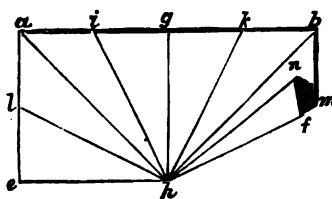


FIG. 109.

A square piece of paper ($abcd$, fig. 108) is folded in the line ef , the edge cd being placed over ab . This double sheet is then creased as represented in the drawing. In the first place the crease gh is produced by laying bf over ae and pressing the thumb-nail over the folded edge so as to produce a sharp crease. Then placing f over g , the crease bh is formed; in like manner the crease ah is formed by laying e over g , and by similar means the intermediate creases l , m , i , and k . These creases are all in one direction, forming seven receding angles, and in making them it is desirable not to bring the creases quite to the point h , but to leave about half an inch or less through which they do not pass, otherwise the frequent foldings of the paper at this point will so weaken the texture as to cause it to break with the weight of the liquid introduced into the filter. In the next place, an equal number of creases are to be made in the opposite direction, bisecting each of the eight sections represented in the upper part of fig. 108. In doing this the edge fh is laid on the crease bh , and then turned back as shown in fig. 109, producing the crease nh . In like manner an intermediate crease is made in each of the other sections, so as to form a sort of fan, as represented in fig. 110. The

points *a b* are cut off with scissors, and the filter opened to its proper angle by separating the originally doubled halves of the paper without disturbing the sharpness of the creases. It will now be found to consist of alternately projecting and receding angles, forming a uniform zigzag circumference excepting at the points *c* and *d* (fig. 110), at each of which places two projecting angles come together. The

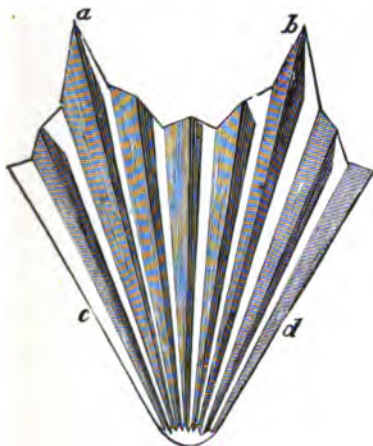


FIG. 110.

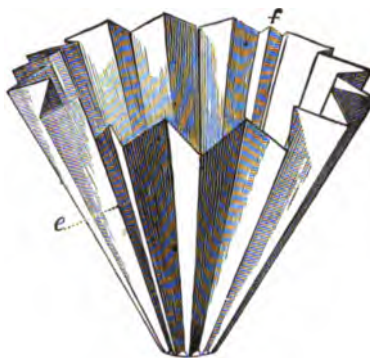


FIG. 111.

intermediate portion of paper between these two angles should be folded so as to form a small receding angle, as shown at *e* and *f*, fig. 111. This figure represents the appearance of a completed filter.

When a filter breaks, the fracture generally occurs at the apex of the cone. This is the part on which the liquid exerts the greatest

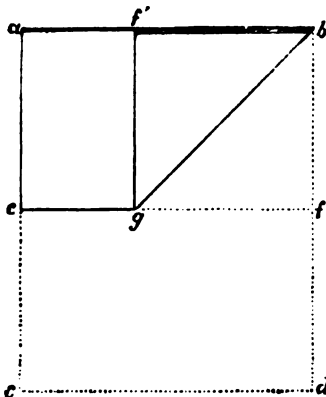


FIG. 112.

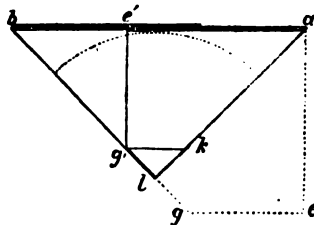


FIG. 113.

pressure, and it also receives the least support from the funnel. The plaited filter especially often breaks at this point, and to obviate this result it may be folded so as to give increased strength where most

needed. The paper used is oblong, and not square. It is folded so as to bring the two short ends $a b$ and $c d$ (fig. 112) together. The edge $b f$ is then laid over $b f'$, producing the fold $b g$. The paper thus folded is now turned over, as shown in fig. 113, and the edge $a e$ laid over $a e'$, producing the fold $a l$. Finally, the projecting points a and b are cut off in the direction of the dotted line. This filter will then have a double thickness of paper at the apex $g' k l$.

Another method of supporting the filter consists in placing a little tow or absorbent cotton in the nozzle of the funnel, so as to form a bed on which the point of the filter may rest. If, however, it is considered worth the trouble, the apex of the filter-paper may be dipped in strong nitric acid and then thoroughly washed in water. This makes the paper vastly stronger, and yet does not altogether stop filtration, the paper being converted into a different substance from that produced by the action of sulphuric acid, as in the preparation of parchment paper. The edge of a filter-paper should never project above the edge of the funnel, but should rather be below it, so as to permit a closely fitting cover being adapted to prevent evaporation.

When considerable quantities of liquids have to be filtered, a

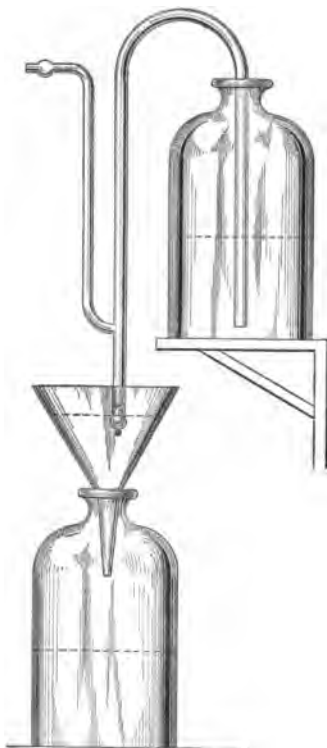


FIG. 114.
CONTINUOUS FILTRATION.



FIG. 115.—FILTRATION OF
VOLATILE LIQUIDS.

constant supply may be maintained by inverting a flask over the filter in the manner described under Extraction (fig. 88). Another good method is that described by E. Robinson in the 'Chemical News' (fig. 114).

To the longer limb of the syphon is attached a short rubber tube. Operating within the lower end of the tube is the cone of a glass float, in the bottom of which are two or three leaden shot. As filtration proceeds the glass bulb descends, permitting the liquid in the syphon to flow out. If the liquid from the syphon flows faster than that through the filter, the float rises and wedges the inside of the rubber tubing. By this means the funnel is kept constantly supplied until all the liquid in the upper bottle has been syphoned out. An important advantage of these arrangements is that when once started they can be left without attention until filtration is complete.

To accelerate filtration of small quantities of liquid through paper, as in the washing of precipitates during the application of group reagents, etc., the following simple plan may be resorted to: Select a perfectly smooth-sided funnel of about three inches diameter, fold a circular filter as fig. 101, and place in the funnel; moisten with water and press gently with the finger so as to ensure a good fit. Pour in the liquid to be filtered and cover the funnel with a glass disc, through which a piece of bent tubing is passed and held in place by a cork above and below, the joint being made with sealing-wax. Now blow gently into the filter, holding the glass cover tightly against the edge of the funnel to prevent escape of air. If the filter-paper has been properly adapted, the filtration of an ounce or two of liquid need not take more than as many minutes. Usually it is necessary to grind the rim of the funnel on the glass plate, using a little emery powder and oil.

Filtration of volatile liquids.—Various methods have been devised to prevent the loss by evaporation that usually attends the filtration of volatile liquids. One of the simplest is to fit a suitable sized wide-mouthed bottle with a tightly fitting cork pierced with two holes. Into one of these the funnel is fixed, a piece of glass tubing passing through the other. A cover fits closely over the top of the funnel, and as it is also fitted with a glass tube, a short length of soft rubber tubing at once prevents access of air and affords an opening for the escape of the air displaced by the filtrate (fig. 115).

The glass percolators made by the York Glass Co. are most useful for filtering volatile fluids (see fig. 93). A plaited filter-paper is placed within the percolator and prevented from slipping by a perforated cone (fig. 107) placed beneath its apex; the liquid is then poured in by means of a guiding rod, and the grooves in the neck of the receiver and stopper turned out of line so as to prevent entrance of air.

Hot filtration is occasionally resorted to for the clarification of substances which are solid or viscous at the ordinary temperatures, such as waxes, fats, and glycerins. The substance should be heated over a water-bath and poured on to a paper filter, supported by a metal funnel kept warm by one of the following contrivances :

In fig. 116 a water-jacketed funnel is kept hot by a ring of gas-jets. In fig. 117 the funnel is also provided with a hot-water jacket, but the heat is maintained by a Bunsen flame beneath the projecting arm. Another simple device for keeping a funnel warm is to wind



FIG. 116.
HOT-WATER FUNNEL WITH
GAS-RING.

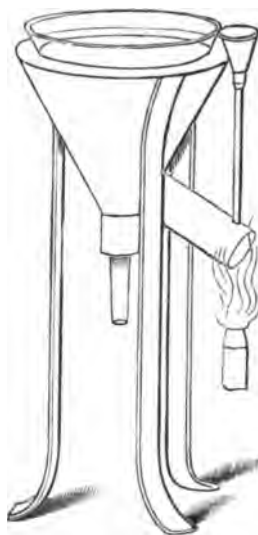


FIG. 117.—HOT-WATER COPPER FUNNEL
WITH SIDE ARM AND SMALL FILLING
FUNNEL, MOUNTED ON THREE LEGS.

round it a coil of ordinary lead piping, through which steam generated in a tin can may be forced. The steam should enter at the top of the coil, and the lower end should dip into a beaker of water. This serves the double purpose of condensing the steam and increasing the temperature by slightly raising the pressure.

Filtration under pressure.—For accelerating the filtration of liquids that under normal conditions filter very slowly, numerous expedients are resorted to, depending on pressure derived from a 'head' of liquid, the use of a filter-press, or the production of a more or less complete vacuum under the filter-bed. All three methods are commonly made use of in pharmaceutical laboratories.

A vacuum may be obtained by connecting the air-tight receiver with a filter-pump as fig. 118. Ordinary filter-papers, however, are not strong enough to bear any great pressure, but require support. This may be afforded by fitting a perforated metal cone into the apex of the funnel, afterwards pressing the wetted paper tightly against

the side to prevent ingress of air. It is found, however, that if the atmospheric pressure is increased ever so little, turbid liquids are drawn through the pores of the paper almost unaltered. To remedy this, a little kieselguhr (infusorial earth) is shaken up with the liquid to be filtered. The suspended matter becomes entangled in the filtering powder, the whole being deposited on the surface of the filter, through which the liquid passes quite bright. Kaolin has also been recommended for the same purpose. When the vacuum is obtained by a water-pump it is necessary to fit a valve between the pump and the receiver, to prevent water being sucked back into the latter in case the pressure in the water main falls. For description of this valve see 'Percolation under Pressure,' page 76.

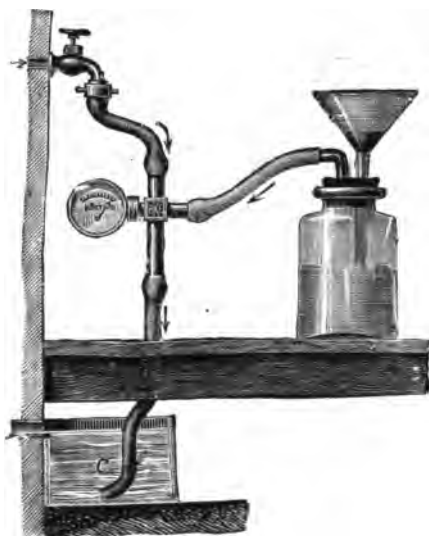


FIG. 118.—FILTRATION UNDER PRESSURE.

Filter-presses.—An excellent form of portable filter-press for comparatively low pressures is shown in figs. 119 and 120. Two discs of asbestos filtering-paper are firmly clamped between the ebonite plates A and B, being held apart by the ring D, through an orifice in which the turbid liquid finds entrance, the filtered liquid leaving the press at a and b. With a head of five feet a pressure equivalent to about a sixth of an atmosphere is exerted, when most liquids filter rapidly.

When, however, large bulks of turbid liquids, as cloudy syrups, Oxymel Scillæ, etc., which do not become brilliant by standing at rest, have to be filtered, it is customary to use a filter-press, as fig. 121.

The principle is very simple: the liquid is pumped into a pipe which feeds numerous filtering chambers, built up in precisely the same way as the foregoing; that is, between each pair of plates is a sheet of filtering material. If the nature of the liquid is such that it does not block the pores of the material and make what is technically called a *surface*, kieselguhr, wood pulp, or other clarifying agent is added. Tinctures and other liquids unaffected by tinned iron are filtered in ordinary presses, but for acid syrups and the like, a diaphragm-pump, with vulcanite connections, and wooden plates, is employed.

In the illustration shown, the liquid is forced in by a power-pump

and escapes from each pair of plates by the little taps shown on the front of the machine ; the plates are held firmly together by the large screw indicated on the right.



FIG. 119.—EBONITE FILTER-PRESS.

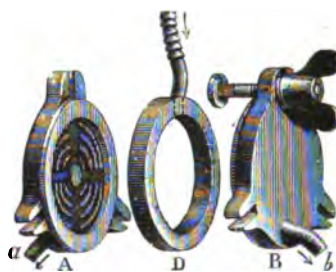


FIG. 120.—EBONITE FILTER-PRESS
(open).

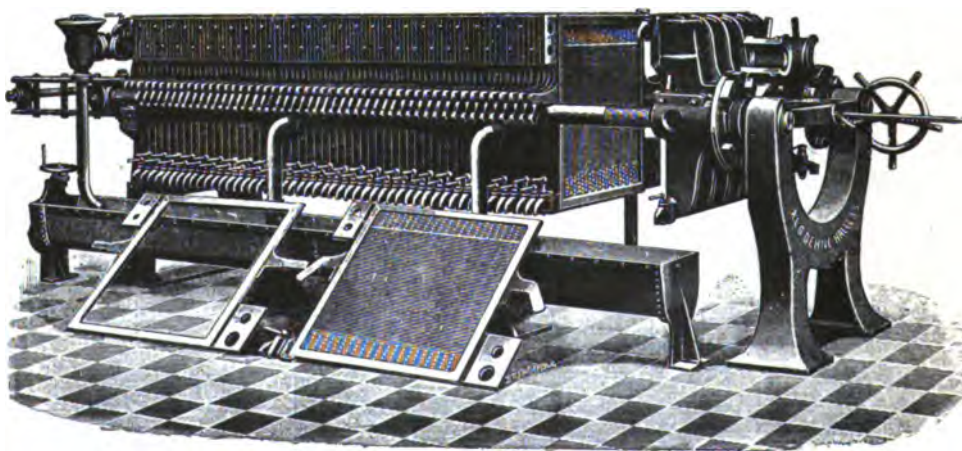


FIG. 121.—FILTER-PRESS.

Filtration of corrosive liquids.—The clarification of strong acids and alkalies is brought about as nearly as possible by subsidence, the clear liquid being drawn off by a syphon (see Decantation). It is fortunate that such liquids deposit readily, and rarely require other treatment. They may, however, in emergency be filtered through a plug of glass wool, inserted in the neck of an ordinary earthenware funnel.

Colation.—Colation, or straining, differs from filtration in that it is made use of for the removal of particles of comparatively large size. The ordinary straining materials are muslin, calico, flannel, felt, horsehair, etc. A useful support or frame is shown in fig. 122.



FIG. 122.—STRAINING FRAME.



FIG. 123.—STRAINING BAG.

Muslin and calico may be stretched and adapted for straining small quantities of liquids by the use of the metal strainers, figs. 124 and 125. For many purposes it suffices to place the straining cloth in an ordinary funnel in the same way as a filter-paper, when, if the liquid passes through slowly, the four corners may be tied together with a piece of string, and the whole suspended from a nail or hook at a convenient height above the receiver, in a similar manner to the straining bag (fig. 123).

Bath-brick filters.—Some time ago the author had occasion to deal with a muddy liquid which refused to filter under ordinary conditions. A trial was made with a Berkefeld filter connected with a

vacuum-pump, good results being obtained, but the 'candles' were so expensive and fragile that some cheaper method had to be



FIG. 124.—STRAINING FUNNEL
FOR MUSLIN OR FLANNEL.



FIG. 125.—METAL STRAINER AND FUNNEL
COMBINED.

devised. After numerous experiments it was decided to establish a battery of filters made of Bath brick, and excellent results were obtained.

A sound Bath brick was selected and rubbed smooth. A hole was then bored three-quarters through its length, into which a glass tube was firmly cemented with magnesia and water-glass paste. On the brick being placed in the liquid to be filtered, and connected with an ordinary filter-pump, a steady flow of perfectly clear filtrate was obtained. It was found advantageous to pass the glass tube through a hole bored in a large cork, the filter-block being securely fastened underneath (fig. 126). By this means *the block always floated just beneath the surface of the liquid* instead of lying buried in the thick deposit at the bottom of the vessel. When the filter-block showed signs of clogging it was withdrawn and, without disconnecting, scrubbed with a stiff brush in a stream of water and replaced. As many such filter-blocks as desired can be connected to the same pump, so that a considerable quantity of intractable liquid can be dealt with at very small outlay.

For ordinary liquids the filters need not be connected with a vacuum-pump, but may be used under the normal atmospheric pressure. The most convenient method of forming filters is perhaps the following. With a sharp knife cut a truncated cone out of a

sound Bath brick, and cement it with magnesia-sodium-silicate paste into a glass funnel. Or, instead of the above, a little cylinder of Bath brick may be fitted with a glass tube and fixed in the throat of a funnel with a cork, as shown in fig. 127.

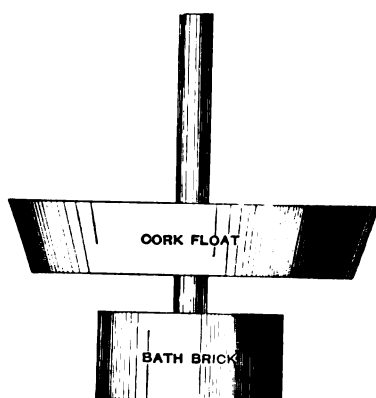


FIG. 126.

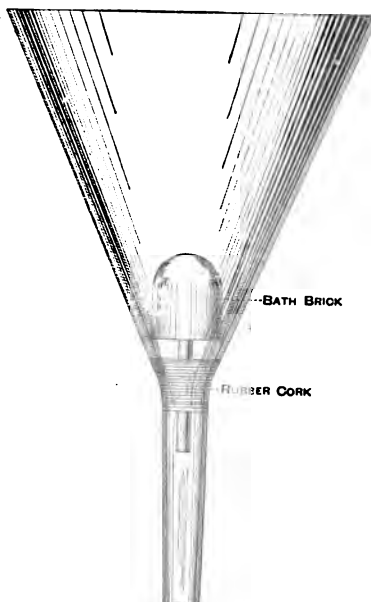


FIG. 127.

For dealing with larger quantities, a bed of Bath bricks may be laid down on sand, the only precaution being to insure that the sides and ends of each brick are perfectly smooth and in intimate contact. When foul, the surface of such a filter-bed is readily cleansed by scrubbing with a stiff broom, the muddy liquid being drawn off at a side exit.

Clarification.—In some cases it is not easy to apply any of the foregoing processes for obtaining clear liquids. Honey, for instance, can only be filtered while very hot, but if it is rapidly brought to the boil, a scum rises to the surface, which may be removed when cool by straining through felt. Again, solutions of gelatin may be obtained perfectly bright by adding white of egg, that has been well stirred up with water, and bringing rapidly to the boil. In this case the albumen coagulates, and carries with it any finely divided matter held in suspension. This is called clarification.

Decantation (Latin *de*, from, and *cantus*, a side, or corner).—When solution of ammonium carbonate is added to solution of ferrous sulphate a precipitate of ferrous carbonate is thrown down. If, after stirring, the mixture is allowed to rest, the precipitate will collect at

the bottom of the vessel, and most of the clear liquid, containing the ammonium sulphate, may be poured off, or *decanted*. This method of washing precipitates is frequently employed, and a little consideration will show how, with three or four washings, the soluble impurity can be practically eliminated.

If the mixture in the first instance measures five gallons and contains 10 per cent. of ammonium sulphate which it is desired to get rid of, it may be assumed that four gallons can be decanted, leaving one gallon of 10-per-cent. solution mixed with the precipitate. If now four gallons of water is stirred in, there results five gallons of 2-per-cent. ammonium-sulphate solution. After a suitable interval four gallons is decanted, leaving one gallon of 2-per-cent. solution. Repetition of this process of *washing by decantation* gives five gallons of 0.4-per-cent. solution, of which four gallons is poured off. On repeating for the fourth time there remains one gallon of only 0.08-per-cent. solution, and the precipitate when collected on calico, drained, and squeezed, can only contain minute traces of sulphate as impurity.

When dealing with comparatively small volumes, it is usual to grease slightly the rim of the pouring vessel. This keeps the fluid in a single stream, preventing it from dividing and running down the side of the vessel. The liquid may also be guided into the receiver by placing a glass rod close to the lip or rim of the pouring vessel, as shown in fig. 128.

When large quantities of liquids have to be decanted from one vessel to another, or when the precipitate is very light and easily disturbed, the transference is usually effected by the aid of a syphon (fig. 129).

In the illustration the syphon is provided with a safety suction tube to avoid danger of corrosive liquids entering the mouth. The shorter leg of the syphon is placed in the liquid so that the extremity reaches to within an inch or two of the precipitate, a short length of rubber tubing, provided with a clip, being at the same time slipped over the upper end of the suction tube. The longer leg of the syphon is also closed with a rubber tube and clip. To start the syphon the upper clip is opened, and suction applied until the liquid nearly fills the suction tube; the clip is then released. The lower clip is next opened and the flow of liquid started.

The action of a syphon may be explained as follows: The shorter leg is first placed in the liquid, which rises until the levels inside and outside the tube correspond. Communication with the outer air is then cut off by the clip at the bottom of the delivery tube and the clip on the suction tube. Now, if the upper clip is opened, and suction applied, a partial vacuum is formed inside the tubes, and the liquid rushes in to take the place of the exhausted air owing to the pressure

of the atmosphere on the surface of the liquid. The syphon is now filled. When the clips are released a flow of liquid ensues, which is more rapid in proportion as the difference of level between the *aperture* of the delivery tube and the *surface* of the liquid in the beaker is



FIG. 128.—DECANTATION.



FIG. 129.—SYPHON WITH SAFETY-TUBE.

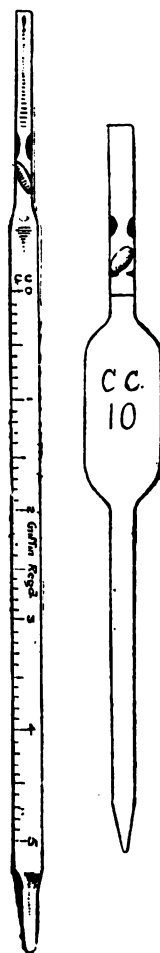


FIG. 130.—SAFETY PIPETTES.

greater. This is explained by the column of liquid in the outer limb of the syphon being longer, and therefore heavier, than the corresponding column in the immersed limb; being heavier, it falls by gravitation, the liquid in the shorter limb being instantly pressed after it by the

pressure of the atmosphere. The shorter limb of the syphon is only reckoned from surface of the liquid to the bend, the portion below the surface playing no part in the operation.

For decanting small quantities of liquid, such as the ethereal layer in the determination of opium, an instrument called a pipette is used. This consists of a glass tube having a very narrow outlet. When liquid is sucked up it may be retained by simply closing the upper orifice. The chief drawback to the use of pipettes, however, lies in the fact that, if a noxious liquid is incautiously drawn into the mouth, disastrous results may ensue.

The author, in order to overcome this difficulty, devised an instrument consisting of an ordinary graduated pipette with a somewhat elongated mouthpiece, with two constrictions about an inch apart. The upper constriction is ground smooth inside, the lower one is grooved, while between the two is a glass bead. The action is as follows: The pipette is placed in the liquid, which is sucked up by the mouth in the usual way. As soon as the liquid reaches the constriction the bead is carried upwards and forced into the second constriction, into which it fits accurately, thus preventing the liquid from entering the mouth (fig. 130).

Separation of Immiscible Liquids

In many pharmaceutical operations it becomes necessary to separate immiscible liquids, such as essential oils, chloroform, petroleum ether, etc., from water or watery solutions. When the operation is of frequent occurrence, and the immiscible liquid is



FIG. 131.
SEPARATING FUNNEL.



FIG. 132.
STOPPERED SEPARATOR.

not volatile, separating funnels, as fig. 131, are used. If the liquid is of a volatile nature, stoppered separators, as fig. 132, must be employed. If neither of these forms of apparatus is at hand, or if the quantities to be dealt with are so great as to preclude the use of the usual sizes, decantation by means of a syphon may be resorted to (see

Decantation), or a funnel of convenient size may be converted into a separator by the device suggested by Currier, the liquid being drawn off by means of a glass tube sliding through a cork. The stem of a funnel is plugged with a cork, through which passes a glass tube closed at its upper end, but having a slit filed through about an inch from the top, so as to afford egress to the liquid. If the tube is pulled down so that the slit is closed by the cork, no liquid can escape; but if pushed up, liquid can be drawn off from any level. Attached to the lower end of the glass tubing is a short piece of rubber tube provided with a pinchcock. The same device is made use of for the separation of volatile liquids, but instead of being adapted to a funnel the tube is fitted to a convenient-sized flask. In addition to the draw-off tube a second tube of fine bore is pushed through the cork until it reaches almost to the bottom of the flask, and serves for the air inlet.

CHAPTER X

DIALYSIS

Dialysis (from the Greek *dia*, from, and *lusis*, a loosing) is a process for the separation of bodies based on their unequal diffusibility. Dialysis was first investigated by Graham, and was described by him in his memoir on 'Liquid Diffusion Applied to Analysis' in the 'Transactions of the Royal Society' for 1861. Ten-per-cent. solutions of the following substances were subjected to dialysis for twenty-four hours; the amounts of substances which passed through the septa bore the following relations to one another :

Gum acacia	.	.	.	.	.	.	.	.	.	4
Cane sugar	.	.	.	.	.	.	.	.	.	214
Starch sugar	.	.	.	.	.	.	.	.	.	266
Glycerin	.	.	.	.	.	.	.	.	.	440
Alcohol	.	.	.	.	.	.	.	.	.	476
Sodium chloride	.	.	.	.	.	.	.	.	.	1000

Graham's dialyser consists of two guttapercha hoops, one of them two inches deep, the other one inch deep. The two-inch hoop is slightly conical, and the one-inch hoop fits over its smaller end. The parchment paper that forms the bottom must be about three inches wider than the small end of the two-inch hoop.

To prepare the dialyser the parchment paper is soaked for a few minutes in water, stretched evenly over the smaller end of the

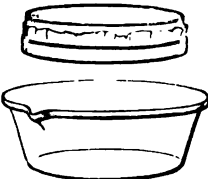


FIG. 133.

two-inch hoop, and strained tightly by pushing on the second hoop. The paper must be pressed smoothly round the outside of the hoop, and the bottom must be quite flat and even, and free from holes. To test this, place some distilled water in the dialyser to the depth of about half an inch, and stand it on clean white blotting-paper. If any dark or wet spots appear, they

indicate the existence of small holes. To close such holes, paint them over with white of egg, put on a small patch of parchment paper, and iron the patch with a hot iron. This coagulates the albumen and closes the holes.

The dialyser being prepared (fig. 133), the liquid to be operated

upon is introduced to a depth of not more than half an inch, and the apparatus floated on distilled water contained in a flat basin. A dialyser of twelve inches diameter will hold about thirty ounces of liquid. In the course of time a more or less complete separation of the component parts of the mixture may be effected; thus, if solution of arsenious acid mixed with bread paste is subjected to dialysis, in a few days most of the arsenic will pass through the diaphragm into the distilled water, from which it may be recovered in the usual way. Substances such as arsenic, salt, etc., which are capable of diffusion, are called *crystalloids*, in contradistinction to those incapable of assuming the crystalline form, such as starch and gelatin, which are known as *colloids*. The term *dialysate* has been proposed for the residue left on the diaphragm after dialysis, the solution of the crystalloids being known as the *diffusate*.

Dialysis is made use of in the preparation of Liquor Ferri Dialysatus. Solution of ferric chloride is saturated with freshly precipitated ferric hydrate, and the filtered liquid placed in a dialyser. Very little iron passes through the septum, dialysis being continued until the diffusate gives no reaction for chlorides. The colloid matter left at the end of the operation has scarcely any taste of iron; it is neutral to litmus paper, and does not give any precipitate with potassium ferrocyanide unless previously warmed with hydrochloric acid; the specific gravity should be about 1.047.

If the operation of dialysis is to be successful the following conditions must be adhered to. The surface of the liquid in the dialyser should not be below the level of the water in the outer vessel, otherwise the bulk of the dialysate becomes unnecessarily increased. In fact, the under side of the dialyser should be only *just below* the surface of the water. If a constant stream of water cannot be made to pass through the outer vessel, the contents should be changed at least twice a day, so as to prevent accumulation of soluble salt in the diffusate. Should this latter be allowed to take place, dialysis proceeds very slowly, and ultimately stops when equilibrium has been established between the amount of crystallisable matter held in solution by diffusate and dialysate respectively.

CHAPTER XI

CRYSTALLISATION

Many definite substances assume under favourable conditions distinct geometric forms, such as the cube, prism, etc.; these are called crystals. All crystals owe their figures to the regularity of internal structure. A crystal, placed in a saturated solution undergoing spontaneous evaporation, increases by constant deposition of fresh matter on its faces. Many solids have a particular crystalline form by which they may often be recognised, although the same substance may assume two or more different forms at different temperatures, when it is said to be *dimorphous* or *polymorphous*. Substances capable of assuming the *crystalline* form are spoken of as *crystallisable*, while uncrystallisable substances, such as gelatin, etc., are termed *amorphous*. The plane surfaces which bound a crystal are called planes or *faces*; the intersection of two adjacent planes forms an *edge*.

All crystalline forms may be divided into six systems, depending upon the length and position of their *axes*. These axes are imaginary lines passing through the central point of the crystal, from end to end, from side to side, or from opposite angles, around which lines the particles forming the crystal are imagined to be deposited. For a full description of the different systems the reader is referred to textbooks specially dealing with crystallography.

Substances more soluble in hot than in cold water may be crystallised by allowing hot solutions to cool very slowly and quietly. If the substance be almost equally soluble in hot and cold water, concentrated solutions may be left to evaporate spontaneously in the air, or they may be slowly evaporated in a partial vacuum. The more slowly and quietly the operation of crystallisation is conducted, the larger and more regular will be the deposited crystals.

Aqueous solutions are usually concentrated until a pellicle or crust forms on the surface, but the degree of concentration is entirely dependent upon the nature of the substance, the quantity of the solution, and the temperature of the surrounding air.

Alum, for instance, is crystallised on a large scale in wooden vats. After a thick crust has formed around the sides and bottom,

the iron hoops by which the staves are held in position are removed, and a hole is cut through the mass to allow the mother-liquor to escape.

It is noted later (under the head of Solution) that supersaturated solutions can be made and kept under certain conditions without crystallising; but in all cases crystallisation may be started by dropping in a crystal, or in many instances by simply rubbing the sides of the vessel, or by placing rough sticks or yarn in the cooling solution.

The liquid remaining after crystallisation has taken place, is called the *mother-liquor*, and on further evaporation yields a second crop of crystals, usually less pure than the first. These may, however, be purified by re-solution and re-crystallisation. If two or more substances are present in a solution, and their solubilities are appreciably different, they may be separated by *fractional crystallisation*; that is, the least soluble crystallises first and the most soluble last, and by re-crystallising each crop, pure crystals may be finally obtained.

Water of crystallisation.—The temperature at which crystals are formed largely determines the composition. Sodium carbonate for instance, crystallises at the ordinary temperature with ten molecules of water, but if deposited between 30° and 40° C. it only contains seven molecules.

The molecules comprising the water of crystallisation are regarded as having entered into a feeble combination with the atoms forming the salt molecule, but this union is not nearly so strong as that which binds the atoms together (see Efflorescence).

Many crystals, such as potassium chlorate, mechanically enclose water during formation. This is known as *interstitial water*, and must be distinguished from water of crystallisation. These crystals decrepitate when heated, owing to the explosive force with which the steam ruptures the crystals.

Granulation may be interpreted in more than one way. When associated with crystallisation we understand the production of granules or coarse grains obtained by agitating concentrated solutions while cooling. The official variety of Epsom salt is an example: if a hot saturated solution is allowed to cool and crystallise quietly, large rhombic prisms are formed instead of the minute crystals with which we are so familiar. Solutions of other freely soluble salts, such as potassium carbonate, are concentrated, and then slowly evaporated to dryness on a steam-bath, stirring constantly all the time. This causes the salt to separate in a finely granular condition. The granular form of ferrous sulphate, formerly official, was ordered to

be made by pouring the filtered solution into strong alcohol, by which means very small crystals were obtained.

The term granulation has also been adopted for the preparation of effervescent salts, as well as for the process to which powders are subjected previous to compression into tablets. This will be treated under a special heading. To add to possible confusion, the name *granule* is also applied to a pill of small size, generally, although not always, sugar-coated.

Deliquescence.—Many salts, such as potassium carbonate, calcium chloride, lithium bromide, etc., possess the property of absorbing water from the atmosphere, becoming damp, and in some instances actually dissolving in the amount of moisture attracted. Such salts are said to be deliquescent.

Certain salts owe their characteristic colour to the amount of water of crystallisation they contain. Thus, copper sulphate containing one molecule of water, $\text{CuSO}_4 \cdot \text{H}_2\text{O}$, is a white salt, but if exposed to moisture it rapidly combines with four more molecules, forming the salt $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, which is blue. The most striking example of the change of colour due to hydration is cobalt chloride, CoCl_2 , which in the anhydrous state is of a deep blue colour, but if exposed to moisture combines with six molecules of water to form the pink salt $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$. A dilute solution of this salt is known as

sympathetic ink. Letters written with it are practically invisible, but if the paper is warmed, the salt loses its water of crystallisation and the characters appear; on cooling they again vanish as water is absorbed from the air.



FIG. 134.—CENTRIFUGAL MACHINE.

Efflorescence is the opposite of deliquescence. Efflorescent salts give up their water of crystallisation on exposure to air, losing their transparency and becoming powdery on the surface.

Alum, on exposure to air, frequently appears efflorescent. This is due not to loss of water, but to absorption of atmospheric ammonia and formation of a basic salt.

Drying of crystals.—Small quantities of crystals may be practically freed from adhering water by lightly squeezing them between folds of blotting-paper. A good deal of the water drains away if the moist

crystals are placed on porous tiles or on well-washed and dried Bath bricks.

Larger quantities may be almost entirely freed from water by means of a centrifugal machine, as fig. 134. The wet crystals are

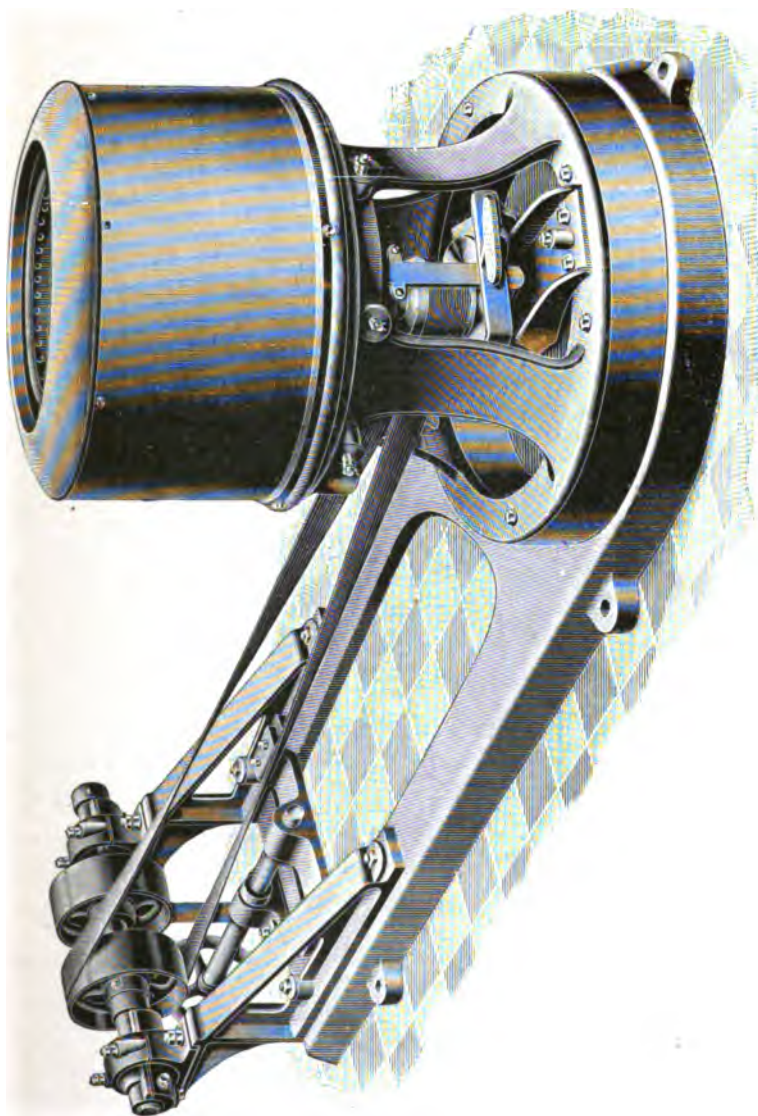


FIG. 135.—POWER CENTRIFUGAL MACHINE.

placed in the inner perforated cylinder, and revolved at a high speed, when the water flies off and is collected in the outer vessel.

Centrifugal drying is frequently employed in pharmaceutical laboratories for removing water or alcohol from extract-marcs, etc.,

and the next figure (fig. 135) shows a much larger machine driven by power.

While on the subject of centrifugal apparatus it may not be out of place to illustrate one of the small laboratory centrifuges commonly employed in the examination of milk, urine, etc. (fig. 136). Such a

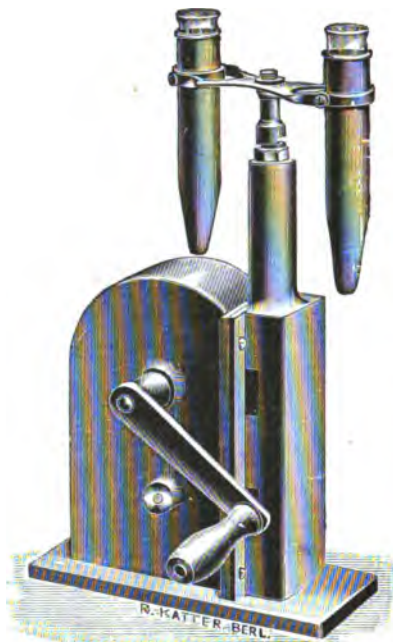


FIG. 136.—LABORATORY CENTRIFUGE.

machine is exceedingly useful for the separation of precipitates in many qualitative and quantitative experiments, as well as for separating the intractable emulsions which occasionally form during the assay of alkaloidal drugs by immiscible solvents.

PART II



PHARMACOPŒIAL PREPARATIONS

CHAPTER XII

ETHYLIC ALCOHOL

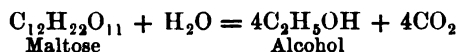
Ethylic alcohol is a product of the fermentation of saccharine liquids. Its manufacture may be briefly divided into three operations:

(a) The preparation of a saccharine liquid by the action of diastase on starch.

(b) Fermentation of this liquid by yeast.

(c) Separation of the alcohol by distillation.

In this country the chief sources of alcohol are the cereals, but in other countries potatoes, maize, beet, etc., are employed. Grain, preferably barley, is moistened and stimulated to germinate by heat. During germination changes take place, a ferment, *diastase*, being formed, which, under suitable conditions, is capable of converting the insoluble starch in the endosperm into maltose and dextrin. At a certain point growth is arrested by drying the grain at a low temperature. As the dried product, *malt*, contains sufficient diastase to convert a considerable amount of added starch, it is mixed with unmalted grain and the ground mixture infused with water at about 60° C., the resulting liquor being known as the *mash*. A second mashing generally exhausts the grain, and the liquors, having been cooled to about 15° C., are mixed with yeast. Fermentation soon commences, the yeast cells multiplying with great rapidity, transforming the sugars into alcohol and carbon dioxide—



The weak alcoholic liquid (containing from 13 to 15 per cent. of alcohol) is next distilled in a fractionating still, the 'head' or upper part of which is so arranged that most of the water is condensed and returned to the still, while the alcohol passes into the receiver. Although with a modern still the strength of the alcohol may reach 80 to 90 per cent., it is not sufficiently pure for medicinal purposes, as it contains traces of other alcohols and impurities which impart to it a disagreeable odour and taste. These are removed by diluting with water, filtering through charcoal, and redistilling.

Rectified spirit of the Pharmacopœia contains 90 per cent. of ethylic alcohol by volume (85·65 per cent. by weight), and has a specific gravity of 0·834. For accurately determining the percentage of alcohol in spirit the density must be ascertained by means of a specific gravity bottle and referred to an alcohol table. For Excise and general purposes, however, hydrometers are usually employed. In England the legal temperature is fixed at 51° F., the spirit being valued not according to percentage of alcohol by volume or weight, but according to the amount of 'proof spirit.' This term is defined by Act 58 George III. as being 'such as shall at a temperature of 51° F. weigh exactly $\frac{1\frac{2}{3}}{1}$ of an equal measure of distilled water.' Proof spirit contains 57·09 per cent. by volume (49·3 per cent. by weight) of ethylic alcohol. Weaker spirits are termed 'under-proof' and stronger spirits 'over-proof.' Thus 25 degrees over-proof, means that 100 volumes of the spirit diluted with water yields 125 volumes of proof spirit; whilst 25 degrees under-proof, means that 100 volumes contains 75 volumes of proof spirit and 25 volumes of water.

To convert percentage of alcohol by weight into percentage by volume

Rule.—Multiply percentage by weight by specific gravity and divide by 0·79367.

Example.—49·5 per cent. by weight = 57·3 per cent. by volume ($49·5 \times 0·920 \div 0·79367 = 57·3$).

To convert percentage of alcohol by volume into percentage by weight

Rule.—Divide 0·79367 by specific gravity and multiply quotient by percentage by volume.

Example.—57·3 per cent. by volume = 49·5 per cent. by weight ($0·79367 \div 0·920 \times 57·3 = 49·5$).

To convert percentage of alcohol by volume into percentage of proof spirit (Sikes)

Rule.—Multiply percentage by volume by 1·7525.

Thus, 90-per-cent. alcohol by volume = 57·725 degrees over-proof ($90 \times 1·7525 = 157·725$).

To convert percentage of proof spirit (Sikes) into percentage of alcohol by volume

Rule.—Divide percentage of proof spirit by 1·7525.

Formula for Diluting a Liquid of any Specific Gravity to any lower Specific Gravity

$$x = \frac{G \times a}{S \times g}$$

where

x = quantity of water to be added, in grammes.

G = weight of liquid to be diluted, in grammes.

- a = difference (in grammes) between known and required specific gravities.

S = specific gravity of liquid to be diluted.

g = difference in weight (in grammes) of the required gravity and that of 1 litre of water.

Example: Given 4000 grammes of a liquid of specific gravity 1.275 to be diluted to specific gravity 1.240; how many grammes of water are required?

x = grammes of water required.

G = 4000 (weight of liquid to be diluted).

a = 35 (difference [in grammes] of specific gravity).

S = 1.275 (specific gravity of liquid to be diluted).

g = 240 (difference in weight [in grammes] of the required specific gravity and that of 1 litre of water).

$$\frac{4000 \times 35}{1.275 \times 240} = 457 \text{ grammes of water required for dilution.}$$

Proportions of Alcohol and Water required to produce one gallon of the weaker Alcohols of the British Pharmacopœia (Bird)

By Weight		Percentage of Alcohol produced by the Admixture	By Measure		Loss by Contraction
90-per-cent. Alcohol	Distilled Water		90-per-cent. Alcohol	Distilled Water	
lb. oz.	lb. oz.		fl. oz.	fl. oz.	fl. oz.
7 6½	1 4½	79.65	141½	20½	2
6 7½	2 6½	70.00	124½	38½	3½
5 9	3 9½	60.00	106½	57½	4
4 4½	5 2½	46.20	82½	82½	4½
4 2½	5 4½	45.00	80½	84½	4½
1 3½	7 14½	20.00	35½	126½	2½

NOTE.—Alcohol mixes with water in all proportions, heat being evolved and contraction taking place. The contraction is greatest when the proportions approximate to the formula $C_2H_5OH + 3H_2O$; i.e., 52.3 volumes of ethylic alcohol and 47.7 volumes of water. If such a mixture is made at 15.5° C. (60° F.), it will be found, when the same temperature is regained, that the mixture only measures 96.35 volumes instead of 100, indicating a contraction of 3.65 per cent. by volume.

Table of the strength of Alcohol ordered in the Pharmacopœias of the more important countries

Pharmacopœia	Specific Gravity at 60° F.	Official Name	Percentage by volume
Austrian	0.830-0.834	Spiritus Vini Concentratus . . .	90-91
	0.894-0.896	" Dilutus . . .	68-70
Belgian	0.794	Alcohol Anhydrous . . .	100
	0.8276	" @ 92° . . .	92
British	0.794-0.7969	" Absolutum . . .	100
	0.834*	Spiritus Rectificatus . . .	90
Danish	0.830-0.834	" Concentratus . . .	90-91
	0.893-0.895	" Dilutus . . .	68-69
Dutch	0.940-0.942	" Tenuis . . .	46-47
	0.831-0.837	" Fortior . . .	89-91
French	0.887-0.892	" Dilutus . . .	69-74
	0.8164	Alcool à 95° . . .	95
German	0.8338	" 90° . . .	90
	0.8639	" 80° . . .	80
Hungarian	0.9135	" 60° . . .	60
	0.830-0.834	Spiritus (Weingeist) . . .	90-91
Italian	0.892-0.896	" Dilutus (verdünnter Weingeist)	68-69
	0.831-0.834	" Dilutus . . .	90-91
Norwegian	0.892	" Dilutus . . .	70
	0.8344	Alcool . . .	90
Portuguese	0.7937	" Assoluto . . .	100
	0.9139	" Diluito . . .	60
Russian	0.8311-0.8344	Spiritus Concentratus . . .	90-91
	0.9026-0.9049	" Dilutus . . .	64-65
Spanish	0.9346	" Tenuis . . .	50
	0.834	Alcool à 90° . . .	90
Swedish	0.850	" 85° . . .	85
	0.905	" 65° . . .	65
Swiss	0.813-0.816	Spiritus Vini Alcoholisatus . . .	95
	0.831-0.834	" Rectificatissimus . . .	90
U.S.A.	0.888-0.890	" Rectificatus . . .	70
	0.952-0.955	" Dilutus . . .	38
	0.796	Alcohol Anhidro . . .	100
	0.833	" de 90° . . .	90
	0.913	" de 60° . . .	60
	0.830-0.834	Spiritus Concentratus . . .	90-91
	0.901-0.905	" Dilutus . . .	64-65
	0.935	" Tenuis . . .	50
	0.812-0.816	" . . .	95-96
	0.892	" Dilutus . . .	69-70
	0.820	Alcohol . . .	94
	0.797	" Absolutum . . .	100
	0.816	" Deodoratum . . .	95
	0.936	" Dilutum . . .	48.6

* Spiritus rectificatus is sold by the rectifiers as 58° over-proof.

Formula for Correction for Temperature in Specific Gravity of Mixtures of Alcohol and Water

$$\text{where } w = w' \pm t \left(0.00014 \times \frac{1 - w'}{150} \right)$$

w' = observed temperature.

w = density at 15.5° C.

t = difference between the normal and observed temperatures in degrees Centigrade.

0.00014 = coefficient of expansion of alcohol.

+ is used if observed temperature is above 15.5° C.

— is used if observed temperature is below 15.5° C.

*Rules for making Alcohol of any required lower percentage from
Alcohol of any higher percentage*

I. *By volume.*

Let the volume-percentage of the stronger alcohol be V.

“ “ “ “ weaker “ v.

Rule.—Mix *v* volumes of the stronger alcohol with sufficient water to produce V volumes of product. Allow the mixture to cool to 60° F., when full contraction will have taken place, and make up any deficiency with water.

Example : Alcohol 30 per cent. by volume is to be made from alcohol 90 per cent. by volume.—Take 30 volumes of 90-per-cent. alcohol, and dilute with water to 90 volumes.

II. *By weight.*

Let the weight-percentage of the stronger alcohol be W.

“ “ “ “ weaker “ w.

Rule.—Mix *w* parts by weight of the stronger alcohol with sufficient water to produce W parts by weight of product.

Example : Alcohol of 50 per cent. by weight is to be made from alcohol of 90 per cent. by weight.—Take 50 parts by weight of 90-per-cent. alcohol, and add enough water to produce 90 parts by weight.

METHYLATED SPIRIT

Under certain conditions two kinds of methylated spirit are permitted to be received by licensed persons; these are *mineralised* spirit and *industrial* spirit. Any person not being a distiller or rectifier of spirits, or a dealer in or retailer of beer, spirits, wines, or sweets, may obtain a licence to receive and sell *mineralised* spirit.

Mineralised spirit may be used for the preparation of the following pharmacopœial liniments, provided they are plainly labelled ‘Methylated’: Linimentum Saponis, Linimentum Camphoræ Ammoniatum, Linimentum Aconiti, and Linimentum Belladonnæ. Apart from these, it is illegal to sell mineralised spirit containing any essential oil or other flavouring matter, or in which the proper quantity ($\frac{3}{4}$ of 1 per cent.) of mineral naphtha, specific gravity about 0·800, has not been dissolved.¹

The foregoing applies only to the *mineralised* methylated spirit used for heating and cleaning purposes, and it is the only kind allowed to be sold by retailers.

¹ In Germany, pyridine bases are used instead of a mineral oil to render alcohol undrinkable, but yet not to impair its value for domestic and technical purposes.

Persons, however, obtaining the sanction of the Revenue Commissioners may receive industrial spirit (which contains 5 per cent. wood naphtha only, and no mineral oil) for use in the arts and manufactures, security being given for its proper use. This kind of methylated spirit must only be used for purposes which are definitely specified, and if at any time it is required for any other fresh, although similar purpose, permission must first be obtained from the Commissioners.

The use of industrial spirit in the preparation of absolute alcohol is illegal, as it involves the purification of the spirit. Permission may be obtained from the Commissioners of Inland Revenue for its use in the preparation of vegetable extracts, medicated cottons and gauzes, etc., provided the whole of the spirit is completely removed from the finished product. The spirit may be recovered by distillation, but care must be taken that the recovered spirit does not become too pure by repeated distillation.

CHAPTER XIII

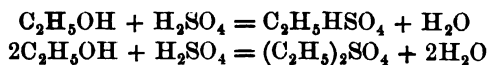
MEDICATED SPIRITS

Of the eighteen official spirits the following are simple solutions of the medicament in 90-per-cent. alcohol :

Spiritus Ætheris	1 in 3 by volume
„ Anisi	1 in 10 „
„ Cajuputi	1 in 10 „
„ Camphoræ (by weight)	1 in 10 „
„ Chloroformi	1 in 20 „
„ Cinnamomi	1 in 10 „
„ Juniperi	1 in 20 „
„ Lavandulæ	1 in 10 „
„ Menthæ Piperitæ	1 in 10 „
„ Myristicæ	1 in 10 „
„ Rosmarini	1 in 10 „

It will be noticed that the solutions of the volatile oils are all 10 per cent. except that of juniper, which is only 5 per cent. The exception is due to the comparative insolubility of oil of juniper berries in 90-per-cent. alcohol, and a note should be made of the fact that the solubility of all volatile oils decreases with age.

Spiritus Ætheris Compositus.—The process, which is a modification of that originally presented for Hoffmann's Anodyne, aims at the production of heavy 'oil of wine,' which after purification is dissolved in a mixture of alcohol and ether. Alcohol and sulphuric acid are allowed to react in the cold for twenty-four hours, mono-ethyl sulphate and di-ethyl sulphate being formed, the mixture assuming an opalescent appearance :



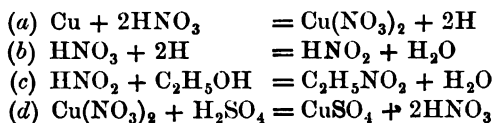
On the application of gentle heat complicated decompositions take place, unaltered alcohol, ether (ethyl oxide), ethyl sulphate, and other products distilling over, accompanied by ethylene, and sulphur and carbon dioxides. The temperature is allowed to rise gradually to 171·6° C. (the bulb of the thermometer being immersed in the liquid), at which point the operation is stopped. The lighter ethereal liquid

is separated from the lower acid layer, washed with solution of sodium bicarbonate to remove the last traces of acid, and dissolved in the mixed spirit and ether. On the addition of the bicarbonate, effervescence ensues, carbon dioxide being given off accompanied by a disengagement of some of the ether.

Operating on the official quantities, the washed ethereal liquid generally measures about nine fluid ounces, and when made up with ether and 90-per-cent. alcohol measures about fifty-two fluid ounces and has a specific gravity of about 0.813. The residue in the retort towards the end of the operation becomes carbonised, and considerable volumes of sulphur and carbon dioxides are evolved. As this carbonisation takes place at the expense of the alcohol, it is evident that the operation is very wasteful, no alcohol being recoverable from the residue even after dilution of the acid liquid.

Spiritus Ætheris Nitrosi.—Spirit of nitrous ether is formed by distilling a mixture of nitric and sulphuric acids with alcohol in the presence of metallic copper. The temperature of the mixture, as indicated by a thermometer the bulb of which is immersed in the liquid, should at first be about 76° C., and should not rise above 82° C. even towards the end of the operation. If this temperature is exceeded, the reaction becomes too violent to be controlled.

The chemical changes that take place are very complicated. Probably copper nitrate is first formed and hydrogen liberated; this, being in the nascent state, at once reduces some of the nitric acid to nitrous acid, which reacts with the alcohol to form ethyl nitrite and water. The copper nitrate formed in the earlier stage is meanwhile decomposed by the sulphuric acid, nitric acid being regenerated and copper sulphate produced. These reactions may be expressed by the following equations :



or combining the equation in one :



Spirit of nitrous ether consists of a mixture of ethyl nitrite, aldehyde (by oxidation of the alcohol), and other products, dissolved in alcohol. Small quantities may be prepared in a distilling flask or retort heated by means of a water-bath, care being taken that at no period of the operation the temperature rises above 82° C. Should the temperature be inclined to rise too rapidly, the heat must be moderated, and the flask cooled by the application of a cloth that has been dipped in cold water.

In an experiment using the pharmacopœial quantities, twenty fluid ounces of alcohol was placed in the receiver, and twenty fluid ounces in the distilling flask. When the distillate measured thirty-two fluid ounces, the operation was stopped and the apparatus allowed to cool. After the addition of the reserved portion of nitric acid two fluid ounces more distillate was collected, equivalent to fourteen fluid ounces in all. *This completed the pharmacopœial process, but it was found that if the heating was continued $5\frac{1}{2}$ fluid ounces more alcoholic distillate, practically free from nitrite, could be obtained.*

Of the thirty-four fluid ounces of mixed distillate, 1 c.c. when tested in a nitrometer, as described below, yielded 18·7 c.c. nitric oxide at N.T.P. Now, the B.P. fixes the maximum yield of nitric oxide at seven volumes, therefore every seven volumes must be diluted with 90-per-cent. alcohol to 18·7 volumes, or thirty-four fluid ounces to ninety-one fluid ounces ($\frac{18\cdot7 \times 34}{7}$).

From this it follows that only ninety-one fluid ounces of spirit of nitrous ether results from the ninety-seven fluid ounces of alcohol used, therefore there has been a loss of six fluid ounces (or over 6 per cent.). This loss may be reduced to three-quarters of a fluid ounce (or 0·8 per cent.) if the distillation is carried a step farther than prescribed by the Pharmacopœia.

The by-products left in the retort are unacted upon copper and copper sulphate. Spirit of nitrous ether should be preserved in small amber-coloured bottles in a cool place. After keeping it becomes acid from oxidation of the aldehyde to acetic acid and from hydrolysis of the ethyl nitrite, alcohol and nitrous acid being formed.

Tests.—The specific gravity varies between 0·838 and 0·842. Ten c.c. mixed with 5 c.c. $\frac{N}{1}$ NaOH and 5 c.c. of water should turn yellow, but not become brown even after standing for twenty-four hours. *This is a test for and limit of aldehyde, which is readily polymerised by the caustic alkali, a coloured resinous body being formed.*

The determination of the ethyl nitrite is carried out as follows: A nitrometer, as fig. 137, is filled with brine, the control tube lowered, and the following run in successively:

Sample	5 c.c. (exact)
10-per-cent. Solution of Potassium Iodide	5 c.c.
Dilute Sulphuric Acid	5 c.c.

The tap must be greased with vaseline, and great care taken that

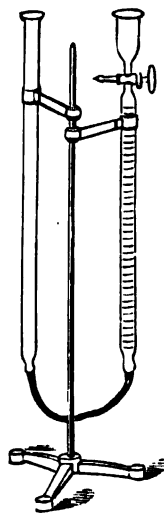
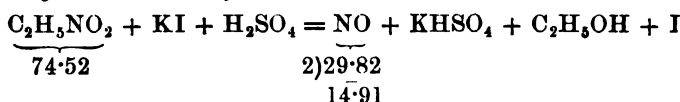


FIG. 137.
NITROMETER.

no air finds entrance. After shaking, the control tube is adjusted so that the level of the brine in the two tubes exactly corresponds, allowed to cool for fifteen minutes, and the reading of nitric-oxide gas taken.

Under the above conditions 5 c.c. should yield at N.T.P., when freshly prepared, at least 31.25 c.c. but not more than 35 c.c. NO. Even after it has been kept for some time and the stopper of the bottle has been occasionally removed, it should yield not much less than 25 c.c. NO, but never less than would correspond to a minimum of 1.75 per cent. by weight of ethyl nitrite.

Example : Supposing 5 c.c. of a commercial sample yielded 30 c.c. NO at 16.5° C. and barometer standing at 756 mm., the percentage of ethyl nitrite may be calculated as follows :



30 c.c. at 16.5° C. and 756 mm., corrected for N.T.P.

$$= \frac{30 \times (273 + 15.5) \times 756}{(16.5 + 273) \times 760} = 29.8 \text{ c.c.}$$

The density of a gas is *half* its molecular weight.

1 c.c. H weighs 0.000896 gramme at N.T.P.

∴ 1 c.c. NO weighs 0.000896 × 14.91 = 0.001336 gramme

∴ 29.8 c.c. NO at N.T.P. weighs 0.001336 × 29.8 = 0.0398 gramme

According to the equation above, 29.82 grammes NO represents 74.52 grammes ethyl nitrite, therefore 0.0398 gramme will represent 0.0977 gramme (74.52 × 0.0398 ÷ 29.82).

Then if 5 c.c. of the sample contains 0.0977 gramme of ethyl nitrite, 100 c.c. will contain 0.0977 × 100 ÷ 5 = 1.95 grammes.

If spirit of nitrous ether had the same specific gravity as water, then the sample under consideration would contain 1.95 per cent. by weight of ethyl nitrite; but as the specific gravity averages about 0.840, 100 grammes would contain $\frac{1.95 \times 1.000}{0.840} = 2.32$ grammes.

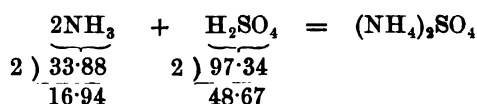
Spiritus Ammoniac Aromaticus.—A *spirituous* solution of the volatile oils is first prepared by distillation and reserved. Next, distillation is pushed a little further and the *aqueous* distillate thus obtained made use of to dissolve the ammonium carbonate, with which is mixed the strong solution of ammonia. Finally the liquids are mixed and filtered through cotton wool.

Aromatic spirit of ammonia is liable to turn brown on keeping. This may be due to one of several causes—contamination with matter acted upon by ammonia; the presence of furfural, which sometimes occurs as an impurity in badly rectified alcohol; or omission of the

distilling process. Furfural turns brown in contact with ammonia; while the oils of lemon and nutmeg oxidise on keeping, products being formed which react with caustic alkalies, especially when kept in a strong light.

Tests.—Specific gravity 0·888 to 0·893. The *total alkalinity* is determined by titration with sulphuric acid, 20 c.c. requiring 25·5 c.c.

$\frac{N}{1}$ H_2SO_4 for neutralisation, corresponding to 2·4 per cent. NH_3 (as combined hydroxide and carbonate) or 2·16 grammes in 100 c.c. Methyl orange is used as indicator, as it does not react with carbonic acid.



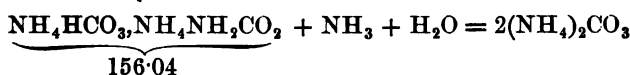
That is, 1000 c.c. $\frac{N}{1}$ $H_2SO_4 = 16\cdot94$ grammes NH_3

\therefore 1 c.c. „ = 0·01694 „ „
 \therefore 25·5 c.c. „ = 0·43197 „ „

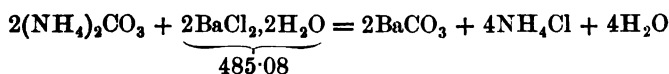
As 0·43197 gramme of ammonia gas is contained in 20 c.c. of the spirit, 100 c.c. will contain 2·15985 grammes.

The *carbonate* is determined separately—20 c.c. of the spirit is mixed with 16 c.c. of barium chloride solution (1 c.c. = 0·1 $BaCl_2 \cdot 2H_2O$), heated to about 70° C., and filtered. If the correct amount of carbonate is present, a further precipitate can be obtained on adding more of the test solution and again heating.

The working of this test depends upon the fact that 16 c.c. of barium chloride solution is not quite sufficient to precipitate the whole of the 0·5 gramme of carbonate which should theoretically be present, therefore the addition of more test solution to the filtrate produces a further slight precipitate. Ammonium carbonate is regarded as consisting of one molecule of acid carbonate (NH_4HCO_3) and one of carbamate ($NH_4NH_2CO_2$), which on the addition of water and ammonia yield two molecules of normal carbonate ($(NH_4)_2CO_3$).



and



As 156·04 grammes requires 485·08 grammes of barium chloride for precipitation, 0·5 gramme will require $\frac{485\cdot08 \times 0\cdot5}{156\cdot04} = 1\cdot554$ gramme,

which is the approximate amount contained in 16 c.c. of barium chloride test solution.

NOTE.—It has been shown by White that this last test is inaccurate, precipitation not being complete unless excess of barium chloride or ammonium chloride be present.

Spiritus Ammoniacæ Fetidus. Fetid Spirit of Ammonia.—The first part of the process consists in preparing a tincture of the asafetida. This is then distilled, and the distillate, which contains the volatile oil, mixed with solution of ammonia.

Tests.—The finished spirit should be colourless, have sp. gr. 0.849, and contain 2.88 grammes of ammonia in 100 c.c.

Spiritus Armoracæ Compositus. Compound Spirit of Horseradish.—The Pharmacopœia simply directs the scraped horseradish root, orange peel, and nutmeg to be added to the alcohol and water and distilled. Oil of horseradish, which is the chief constituent of the distillate, is similar in composition to volatile oil of mustard, and, like the latter, does not exist in the plant, but is formed by the reaction of a glucoside, potassium myronate, with a ferment allied to myrosin, in presence of water. Having regard to this, it would appear better pharmacy to allow the scraped horseradish to macerate in water at the ordinary temperature for several hours, so as to ensure completion of the reaction, the ferment being destroyed both by strong alcohol and by heat.

CHAPTER XIV

TINCTURES

Two methods are followed in the preparation of tinctures—maceration and percolation. These methods are described at length under Extraction. By either process the medicinal properties of almost all drugs may be obtained in solution, menstruum of such alcoholic strength being employed as will ensure complete exhaustion without at the same time extracting albuminoids, gum, and other inert matter.

Maceration.—The material, having been reduced to coarse powder, is placed with the menstruum in a closed vessel for a definite period, usually a week, and agitated at intervals. Small quantities may be set-on in a wide-mouthed bottle, larger quantities in bung-jars. Large bungs are generally cut from very poor cork, and therefore require to be made tight with thick plaster-leather to prevent loss.

When exhaustion is complete, the liquid portion is strained off, the residue (marc) wrapped in cloth and submitted to pressure, when more liquid is obtained. The two liquids are then mixed and filtered, *but are not made up to any definite bulk* by addition of more menstruum. The reason for this is that no two operators would press the marc equally, so that if made up the finished tincture would vary considerably in strength. By not making up, tinctures prepared by different workers should be of uniform composition no matter how much is left behind in the marc, as both that and the expressed liquid should also be of equal strengths. That is, different operators may produce different quantities of tincture from the same material, but the percentage composition of the finished preparations should be identical.

In the ordinary way it scarcely pays to recover the alcohol left in a few ounces of press-cake, but when considerable quantities are worked it becomes imperative to save all waste products containing alcohol and distil them. Fig. 89 shows a diagram of a recovery

still which gives excellent results, and with suitable modifications nearly the whole of the spirit may be recovered. As will be assumed, the recovered spirit nearly always possesses the characteristic odour of the drug from which it has been recovered, and must therefore be set on one side to be used for the same preparation next time it is required.

The following table gives the average specific gravity, yield of alcohol, extractive, and total product obtained in preparing the pharmacopœial quantities of the *eighteen tinctures prepared by maceration* :

	Average Specific Gravity	Percent- age of Alcohol by volume	Extrac- tive (grammes per 100 c.c.)	Product from 1 pint (fl. oz.)
<i>Tinctura Aurantii</i>	0·916	73·6	1·69	21·6
„ <i>Calumbæ</i>	0·920	57·0	0·86	19·2
„ <i>Cantharidis</i>	0·836	89·1	0·17	20·0
„ <i>Capsici</i>	0·895	68·0	0·98	19·6
„ <i>Cardamomi Composita</i>	0·952	53·3	6·60	19·4
„ <i>Catechu</i>	0·982	51·4	14·50	20·8
„ <i>Cocci</i>	0·950	42·5	2·30	19·1
„ <i>Croci</i>	0·926	57·5	2·50	18·9
„ <i>Gentianæ Composita</i> .	0·965	42·3	4·24	18·6
„ <i>Lavandulæ</i>	0·840	88·3	0·5	19·8
„ <i>Limonis</i>	0·879	76·1	1·41	21·6
„ <i>Lupuli</i>	0·940	54·0	3·8	18·1
„ <i>Pruni Virginianæ</i> .	0·931	54·0	2·4	18·1
„ <i>Quassia</i>	0·946	43·5	0·38	19·4
„ <i>Scillæ</i>	0·968	51·8	11·0	17·4
„ <i>Sennæ Composita</i> .	0·987	39·2	8·3	18·5
„ <i>Sumbul</i>	0·903	66·1	2·41	18·8
„ <i>Valerianæ Ammoniata</i>	0·941	50·2	2·98	18·3

NOTES

Tinctura Aurantii, *Tinctura Limonis*.—The freshly peeled rind of fruit in good condition contains about 60 per cent. of water.

Tincture Calumbæ.—*Natural* calumba root should be used, and not the high-coloured trade article, which is treated to improve (?) its appearance.

Tinctura Cardamomi Composita.—Raisins yield so much extractive that nearly a pint of tincture may be pressed off.

Tinctura Catechu Composita.—Good catechu, yielding less than 5 per cent. ash, gives a very high extractive.

Tinctura Pruni Virginianæ.—The bark contains the ferment *emulsin* as well as a glucoside closely resembling *amygdalin*, and these in the presence of water react to form hydrocyanic acid and a volatile oil, hence the preliminary maceration in water. The reaction does not take place in spirit, strong alcohol coagulating the ferment. (Compare *Ol. Amygd. Essent.*)

Tinctura Scillæ.—The yield of tincture is dependent upon the condition of the root, the percentage of moisture varying considerably.

The seven following tinctures are also prepared by maceration, but as the ingredients consist of resins or gum-resins the insoluble residue is comparatively small, and is, moreover, not so well adapted for pressing. The clear tincture is decanted, and the residue, having been poured upon a filter, is washed with sufficient menstruum to produce the required volume :

— —	Average Specific Gravity	Extractive (grammes per 100 c.c.)	Alcohol Per- centage by volume
Tinctura Aloës	0·976	7·4	39·0
„ Asafetidæ	0·916	9·7	62·0
„ Benzoini Composita .	0·895	16·1	74·4
„ Guaiaci Ammoniata .	0·902	15·5	70·0
„ Kino	0·997	22·0	50·0
„ Myrrhæ	0·853	4·4	84·1
„ Tolutana	0·866	7·9	82·0

Percolation (see also *Extraction*).—The material having been reduced to the required state of comminution, it is *intimately mixed* with about an equal weight of menstruum and set aside in a closely covered vessel for twenty-four hours for the tissues to swell. Were this omitted and the drug packed in a dry state, in all probability the upper layers would, as soon as the menstruum was poured on, swell to such an extent as to block the percolator and stop the process.

At the end of the time, the drug having swollen to its greatest bulk, it is placed in a percolator, each portion being gently tapped down. This must be done as evenly as possible to obviate the likelihood of channels being formed down which the menstruum might trickle direct to the receiver without first passing through the drug. It must be remembered that the object in view is to cause the whole of the liquid to pass in turn through the whole bulk of the solid. A piece of filter-paper placed over the top serves to break the force of the menstruum when it is poured on, the latter being added in such portions that a layer of liquid is maintained until about three-fourths of the required volume has collected, when, if properly managed, the apparatus should have ceased dropping. The marc is then removed, pressed strongly, the expressed liquid filtered into the bright percolate, and the whole adjusted to the prescribed volume by the addition of more menstruum.

The alcohol retained by the press-cake, press-cloth, filter-paper, etc., is recovered as previously described under *Maceration*, and used next time the same tincture has to be prepared.

The following twenty-seven tinctures are prepared by percolation :

	Average Specific Gravity	Average Extractive (grammes per 100 c.c.)	Average Alcohol Percentage by volume
Tinctura Aconiti . . .	0·900	1·5	66·0
„ Arnicae . . .	0·896	0·71	67·6
„ Buchu . . .	0·932	3·7	56·0
„ Cascarillae . . .	0·900	2·3	66·0
„ Chiratae . . .	0·923	1·1	57·2
„ Cimicifugae . . .	0·923	1·33	57·1
„ Cinnamomi . . .	0·901	1·8	66·0
„ Colchici Seminum . . .	0·951	2·0	43·0
„ Conii . . .	0·899	1·3	66·5
„ Cubebae . . .	0·843	1·35	84·0
„ Digitalis . . .	0·933	3·36	55·8
„ Ergotae Ammoniata . . .	0·938	3·29	50·8
„ Gelsemii . . .	0·924	1·26	56·8
„ Hamamelidis . . .	0·953	1·68	44·0
„ Hydrastis . . .	0·929	2·3	55·8
„ Hyoscyami . . .	0·954	2·9	42·0
„ Jaborandi . . .	0·958	2·45	42·4
„ Krameriae . . .	0·940	4·8	55·0
„ Lobeliae Ætherea . . .	0·814	1·4	—
„ Pyrethri . . .	0·902	1·66	68·1
„ Quillaiae . . .	0·922	1·2	57·0
„ Rhei Composita . . .	0·973	12·5	49·4
„ Senegae . . .	0·941	4·6	54·7
„ Serpentariae . . .	0·898	1·5	67·0
„ Stramonii . . .	0·958	3·4	43·0
„ Strophanthi . . .	0·895	0·51	68·6
„ Zingiberis . . .	0·840	0·35	88·0

The following seven tinctures are prepared by simple solution of the ingredient or ingredients in the menstruum :

	Average Specific Gravity	Average Extractive (grammes per 100 c.c.)	Average Alcohol Percentage by volume
Tinctura Camphorae Composita	0·920	0·31	57·0
„ Cannabis Indicæ . . .	0·847	3·7	86·0
„ Chloroformi et Morphinae Composita	1·015	—	52·5
„ Ferri Perchloridi . . .	1·087	12·0	22·0
„ Iodi . . .	0·880	2·521	85·0
„ Quininæ . . .	0·890	3·5	74·0
„ „ Ammoniata . . .	0·927	1·8	53·0

NOTES

Tinctura Ferri Perchloridi.—When this tincture is exposed to sunlight it gradually becomes lighter in colour, owing to reduction of some of the iron to the ferrous state.

Tinctura Iodi.—It has been stated that iodine slowly reacts with alcohol at ordinary temperatures, hydriodic acid being formed.

Standardised Tinctures

The following seven tinctures are standardised and a somewhat different procedure is adopted for each :

—	Proportion of Active Ingredient in 100 c.c.	Specific Gravity	Extractive (grammes per 100 c.c.)	Alcohol Percentage by volume
Tr. Belladonnæ .	0·05 gramme Atropine	0·918	—	60·5
„ Cinchonæ .	1·00 „ Total Alkaloid	0·920	5·4	64·6
„ „ Co. .	0·50 „ „	0·916	4·5	64·7
„ Jalapæ .	1·50 „ Resin	0·912	3·7	66·0
„ Nucis Vomiceæ .	0·25 „ Strychnine	0·912	—	61·0
„ Opii .	0·75 „ Morphine	0·957	3·3	44·1
„ Iodi .	2·50 „ Iodine	0·880	2·52	85·0

*Tinctura Belladonnæ.—**Preparation*

Liquid Extract of Belladonna 2 fl. oz. 60 c.c.
Alcohol (60-per-cent.) 28 fl. oz. 840 c.c.

Note the unusual quantity produced.

On evaporation to a low bulk, and subsequent treatment by the assay process described under *Extractum Belladonnæ Liquidum*, each 100 c.c. should yield not less than 0·048 and not more than 0·052 gramme of alkaloid.

Many people object to a dark-coloured tincture, hence liquid extract obtained from root rich in alkaloid but poor in extractive matter should be used. The alkaloid naturally exists as hyoscyamine, but is mostly converted into atropine in the process of manufacture.

*Tinctura Cinchonæ.—**Preparation*

Red Cinchona Bark, in 40 powder . . 4 oz. 200 grammes
Alcohol (70-per-cent.) a sufficiency

The powdered bark is directed to be percolated until 14 fluid ounces (700 c.c.) of percolate has been collected, when the marc is pressed and the expressed liquid mixed with the percolate. The resulting strong tincture is then assayed according to the process given under *Extractum Cinchonæ Liquidum* (10 c.c. being utilised for the test), 70-per-cent. alcohol being added so that the finished tincture shall contain not less than 0·95 gramme and not more than 1·05 gramme of total alkaloid in 100 c.c.

It should be noted that percolation with alcohol is a very inefficient process for extracting the alkaloids. Tincture of cinchona darkens rapidly on exposure to light.

Tinctura Cinchonæ Composita.—*Preparation*

Dried Bitter Orange Peel, well bruised	1 oz.	50 grammes
Serpentary Rhizome, in No. 40 powder	$\frac{1}{2}$ „	25 „
Cochineal Powder	28 grains	3.2 „
Saffron	55 „	6.2 „
Tincture of Cinchona	10 fl. oz.	500 c.c.
Alcohol (70-per-cent.) sufficient to produce	1 pint	1000 c.c.

The solid ingredients are exhausted by maceration, the filtered product being made to measure ten fluid ounces (500 c.c.), which is then mixed with the simple tincture of cinchona.

Ten c.c., when assayed by the process described under *Extractum Cinchonæ Liquidum*, should yield not less than 0.045 gramme and not more than 0.055 gramme total alkaloid; i.e., half the strength of *Tinctura Cinchonæ*. A qualitative test for saffron is also added—2 c.c. of the tincture when evaporated being required to yield a yellow colour to chloroform.

Tinctura Jalapæ.—*Preparation*

Jalap, in 40 powder	4 ounces	200 grammes
Alcohol (70-per-cent.)	a sufficient quantity	

The powdered jalap is exhausted by percolation, the resulting tincture being made to measure about fifteen fluid ounces. Ten c.c. is mixed with a few c.c. of water and the alcohol driven off by heat. The separated resin is then collected, washed with hot distilled water, and dried. It should weigh not less than 0.145 gramme and not more than 0.155 gramme, corresponding to an average of 1.5 grammes of resin in 100 c.c.

Tinctura Nucis Vomicae.—*Preparation*

Liquid Extract of Nux Vomica	2 fl. oz.	100 c.c.
Distilled Water	3 fl. oz.	150 c.c.
Alcohol (90-per-cent.)	7 fl. oz.	350 c.c.

Note the unusual quantity of tincture produced.

Treated by the assay process given under *Extractum Nucis Vomicae Liquidum*, 100 c.c. should yield not less than 0.24 nor more than 0.26 gramme of strychnine, corresponding to about one-eighth grain in one fluid drachm or one grain in 110 minims.

In the preparation of this tincture preference should be given to a pale-coloured liquid extract, as a dark-coloured article is frequently objected to from a dispensing point of view.

Tinctura Opii.—*Preparation*

Opium	3 oz.	150 grammes
Alcohol (90-per-cent.)	}	of each a sufficient quantity
Distilled Water		

Pour ten fluid ounces (500 c.c.) of the water, previously heated to 93·3° C., on to the opium contained in a mortar, and rub to a paste; stand for six hours; add ten fluid ounces (500 c.c.) of the alcohol, mix thoroughly, and set aside for twenty-four hours, stirring occasionally. Strain, press, mix the liquids, set aside for twenty-four hours, and filter.

In the strong tincture resulting from the above, the proportion of morphine is determined as follows:

Pour 80 c.c. into a porcelain dish and heat over a water-bath until reduced to 30 c.c. *This serves to get rid of the alcohol, and therefore concentrates the alkaloidal solution.* Mix the residue very evenly with 3 grammes of freshly slaked lime, and dilute with water to exactly 85 c.c. Set aside for half an hour, stirring occasionally. *The lime serves two purposes: firstly, it decomposes the natural salts of the alkaloids, insoluble calcium meconate being formed; secondly, some of the excess of lime dissolves in the water, the morphine and narcotine only passing into solution.*

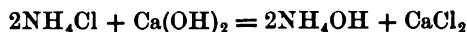
Filter off 50 c.c. (representing 50 c.c. of the strong tincture—the remaining 5 c.c. being accounted for by the extractive matter) into a wide-mouthed stoppered flask having a capacity of about 150 or 200 c.c., and add

Alcohol (90-per-cent.)	5 c.c.
Ether, 0·735	30 „

Shake vigorously and add

Ammonium chloride	2 grammes
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Shake well and frequently during half an hour, and stand for twenty-four hours for the morphine to crystallise out. *The precipitation of the morphine is brought about by the interaction of the ammonium chloride and slaked lime, ammonia being formed—*



—in which both morphine and narcotine are insoluble. The narcotine is dissolved by the ether. The alcohol is added to facilitate the crystallisation of the morphine.

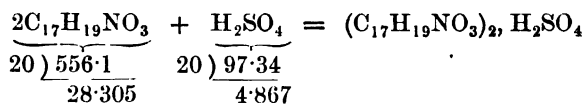
Next, counterbalance two small filters, placing one within the other in such a way that the folded portions are opposite to each other, and moisten with ether. Remove the ethereal layer from

the flask by means of a pipette and transfer it to the filter ; pour into the flask 15 c.c. more ether, shake *gently*, and set aside for a short time. When separation is completed, transfer the ethereal washings to the filter as before, and when all has passed through wash the filter with 10 c.c. more ether, added in portions ; allow the filter to dry in the air. *This treatment is to get rid of the narcotine, which is fairly soluble in ether. A little more morphine also dissolves, but as the loss is constant for the definite volume of ether employed, it is allowed for in the final calculation. As all the filtrate passes through BOTH the counter-balance filters, it is assumed that their weights will also be identical when they are again dried.*

Pour the contents of the flask on to the filter in such a way that the crystals of morphine are transferred as completely as possible. When all the liquid has passed through, wash the remainder of the morphine from the bottle with morphinated water. *This is facilitated by rubbing the inside of the flask with a bent glass rod, one end of which is covered with a small rubber cap.*

Wash the crystals until they are practically free from colour ; allow the filter to drain, and dry it first by pressing between sheets of blotting-paper, afterwards at a temperature between 55° and 60° C., finally raising the temperature to 110° C. for two hours. *This can only be done in an air-oven. Morphinated water is used to prevent loss of alkaloid during the washing process ; it is already saturated with morphine, so cannot take up any more.*

Weigh the anhydrous morphine in the inner filter, counterbalancing by the outer one. Then take 0.3 gramme (exactly) and dissolve in 20 c.c. $\frac{N}{10}$ H_2SO_4 , and titrate back with $\frac{N}{10}$ KOH, using cochineal as indicator.



That is, 1000 c.c. $\frac{N}{10} H_2SO_4 = 28.305$ grammes anhydrous morphine

\therefore 1 c.c. " = 0.0283 gramme " "

\therefore The number of c.c. of $\frac{N}{10} H_2SO_4$ in combination with the morphine $\times 0.0283$ = the weight of anhydrous morphine in the 0.3 gramme originally taken.

From this result calculate the morphine originally present on the filter-paper, which, it will be remembered, was the yield from 50 c.c. of the strong tincture, and add the correction 0.05 for loss during the process. Having ascertained this, dilute the bulk of the strong tincture with sufficient 45-per-cent. alcohol to produce a

tincture of opium containing 0.75 gramme of anhydrous morphine in 100 c.c.

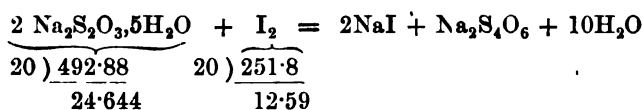
Example: *Supposing the weight of the crystals on the filter-paper was 0.47 gramme, and that 0.3 gramme titrated as above indicated 0.28 gramme anhydrous morphine; then 0.47 would contain 0.438 of anhydrous morphine, and $0.438 + 0.05$ (correction for loss) = 0.443 gramme of morphine in 50 c.c. of strong tincture, or 0.886 gramme in 100 c.c. Therefore 84.6 volumes of the strong tincture must be diluted with 45-per-cent. alcohol to 100 volumes ($\frac{100 \times 0.75}{0.886} = 84.6$).*

Instead of taking an aliquot part of the alkaloid for titration it has been suggested to mash up the inner filter and its contents with a known volume of $\frac{N}{10}$ acid and to titrate back with $\frac{N}{10}$ alkali, a check being performed at the same time with the outer filter under identical conditions. This is undoubtedly more satisfactory than the B.P. process.

Tinctura Iodi.—

Iodine	$\frac{1}{2}$ ounce	25 grammes
Potassium Iodide	$\frac{1}{2}$ „	25 „
Distilled Water	$\frac{1}{2}$ fl. ounce	25 c.c.
Alcohol 90-per-cent. to produce	1 pint	1000 c.c.

Test.—10 c.c. of the tincture, diluted with 20 c.c. of water, should require for complete decoloration 19.6 c.c. of $\frac{N}{10}$ 'hypo' solution, mucilage of starch being used as an indicator towards the end of the reaction.



1000 c.c. $\frac{N}{10}$ 'Hypo' contain 24.644 grammes crystallised salt

∴ 1000 c.c. „ = 12.59 „ iodine
 ∴ 1 c.c. „ = 0.01259 „ „
 ∴ 19.6 c.c. „ = $0.01259 \times 19.6 = 0.246$, equivalent
 to 2.46 grammes iodine in 100 c.c. of tincture.

Dosage of the Tinctures

According to their potency the tinctures fall into two classes: The More Potent Tinctures, with doses of five to fifteen minims; the Less Potent Tinctures, with doses of half to one fluid drachm. *Tincture of iodine is an exception; dose, two to five minims.*

The following are the More Potent Tinctures :

		Ordinary Dose	Strength
		Minims	
Tinctura	Aconiti	5-15	1 in 20 of Aconite Root
„	Belladonnæ	5-15	0·05 per cent. of Alkaloid
„	Cannabis Indicæ	5-15	1 in 20 of Extract
„	Cantharidis	5-15	1 in 80 of Cantharides
„	Capsici	5-15	1 in 20 of Capsicum
„	Chlorof. et Morph. Co.	5-15	1 per cent. Morphine ; 5 per cent. dilute Hydrocyanic Acid
„	Colchici	5-15	1 in 5 of Colchicum Seeds
„	Digitalis	5-15	1 in 8 of Digitalis
„	Gelsemii	5-15	1 in 10 Gelsemium Root
„	Lobeliæ Ætherea	5-15	1 in 5 Lobelia
„	Nucis Vomiceæ	5-15	0·25 per cent. Strychnine
„	Opii	5-15	0·75 per cent. Morphine
„	Podophylli	5-15	3·65 per cent. Podo- phyllum Resin
„	Scillæ	5-15	1 in 5 of Squill
„	Stramonii	5-15	1 in 5 of Stramonium
„	Strophanthi	5-15	1 in 40 of Strophanthus

The following tinctures also have doses ranging from five to fifteen minims, but they are not classed as potent remedies :

Tinctura Cocci

„ Croci

„ Ferri Perchloridi

Note on Deposits in Tinctures, etc.—It will often be noticed that although a newly made tincture may be put away bright, after the lapse of a few days an unsightly deposit commences to form. This deposition may continue for a very long time, until at last it becomes a matter of speculation as to whether the preparation retains any of its original virtue.

Tinctures are solutions of organic compounds in various menstrua, and as such they are governed by the laws to which ordinary solutions are subject, especially those relating to changes produced by alterations of temperature or by concentration. They may become turbid if the temperature is lowered, from which it follows that a tincture prepared at a temperature of 15° to 20° C. should be kept at that temperature, and not in a cellar the temperature of which may be as low as 10° C.

Professor Kunz-Krause has shown that, in addition to changes due to these causes, intra-molecular changes also occur, due to other causes that are not at present thoroughly understood. The deposit that forms in tincture of galls is produced by the transformation of gallotannic acid into the less soluble ellagic acid. Tincture of litmus loses its colour by suffering a reduction, whilst astringent tinctures deposit phlobaphenes as a result of oxidation or hydrolytic processes. Sunlight has long been

recognised as an important factor in the changes observed in tinctures. Many become paler in colour when exposed to sunlight, as tincture of saffron, while others darken, as tincture of rhubarb.

In addition to the changes brought about by sunlight, various alterations are produced by enzymes originally present in the drugs, which pass into the tinctures prepared from them. These enzymes may be classified as follows :

(1) *Hydrolytic Enzymes* which enable the substances they act upon to take up one or more molecules of water and split up into other bodies, as : (a) *Diastase, inulase, cytase*, etc., which convert starch and other polysaccharides or polyoses of the formula $C_6H_{10}O_5$, into various soluble compounds. (b) *Invertase, maltase, raffinase, melizitase*, etc., which convert bioses of the formula $C_{12}H_{22}O_{11}$, such as cane sugar, maltose, etc., into monosaccharides (monoses). (c) *Lipase*, which splits up fats into acids and glycerin. (d) *Emulsin*, which splits up amygdalin into a benzaldehyde compound and glucose.

(2) *Autolytic Enzymes*, which effect decomposition without the absorption of water : (a) *Zymase*, which converts glucose into alcohol and carbon dioxide. (b) *Myrosin*.

(3) *Coagulating Enzymes*, as *Pectase*, which converts the so-called pectins into gelatinous masses.

Recent investigations have shown that oxydases (oxidising enzymes) are very widely distributed in the vegetable kingdom, and are probably the principal causes of the changes, due to oxidation, that take place in tinctures. Very possibly other enzymes concerned in the metabolic processes of the plant are also present in tinctures, and are not without influence on them. At any rate, it is now well known that many tinctures, which under ordinary conditions go on depositing almost indefinitely, will remain clear if they are previously sterilised. An example of this is seen in tincture of squill. Other tinctures, as tincture of kino, gelatinise on keeping ; this gelatinisation may be prevented by heating the tincture in a closed vessel to 80° C. for half an hour. The improvement in both these cases is undoubtedly brought about by the destruction of the enzyme by heat.

CHAPTER XV

EXTRACTS

Drugs when treated with suitable liquids may be made to yield their principles in the form of solution, and when the solvent liquid is removed, an *extract* or *concentrate* is left, which represents in a solid form the active portion of the original drug. In general the powdered or bruised material is exhausted by the processes of maceration, percolation, infusion, decoction, etc. An extract therefore presents the active principle of a drug in a concentrated and permanent form suitable for administration. The choice of the menstruum depends upon the physical characteristics and nature of the constituents of the drug to be operated upon. Where the active principles are soluble in water and the temperature employed during concentration is no drawback, water is clearly the most economical solvent. In many cases, however, water extracts so much gum, albuminous, and other inert matter as to render its employment undesirable. In such cases alcohol is almost invariably used, while it is always employed for the extraction of resinous and alkaloidal substances. There are one or two exceptions, ether and dilute acids being occasionally used as solvents. These will be considered later on.

Liquid extracts only differ from the extracts described above, in that concentration is not carried to the end, sufficient menstruum being left to keep the extractive matter permanently in solution and in such proportions that one fluid part of liquid represents one part by weight of the original drug.

CLASSIFICATION OF THE EXTRACTS

The solid or semi-solid extracts may be classified as follows

Aqueous Extracts

Extractum Aloës Barbadosensis

- „ Cascaræ Sagradæ
- „ Krameriæ
- „ Anthemidis
- „ Gentianæ
- „ Glycyrrhizæ
- „ Opii (standardised)

Of these, the first three are evaporated to dryness and the extract reduced to powder. The remaining four are evaporated to a varying consistence—a semi-solid or stiff paste. The stopping of evaporation while removable moisture remains in the extract is probably due to the fact that in earlier days it was impossible to remove the whole of the water without impairing the product by exposure to the prolonged heat necessitated by drying in open steam-pans or hot-air ovens. Now that vacuum pans have come into such general use in pharmaceutical laboratories the reason for leaving the process incomplete no longer obtains.

Dry Watery Extracts

Extractum Aloës Barbadosis.—The Aloës, in small fragments, is exhausted by *boiling water*, the separated resinous matter being removed by subsidence or by filtering through a filter-press. The clear liquid is then evaporated in a tinned or aluminium pan to dryness. Copper is unsuitable. The resulting extract is never completely soluble in water again owing to some change taking place in the extract during the process of evaporation. If, however, the liquid when fairly concentrated is exposed to a temperature below the congealing point of water, again filtered, and then evaporated to dryness *in vacuo*, a perfectly soluble extract may be obtained. Extract prepared in a similar way was at one time in vogue under the name *Extractum Aloës Glaciale*.

Yield.—The average product, consisting largely of barbaloin, varies from 65 to 75 per cent.

Extractum Cascaræ Sagradæ.—Cascara bark, coarsely ground, is placed in a percolator and exhausted by percolation with cold water. With a view to reducing the amount of water to be evaporated, it is usual to draw off the first percolate and return it several times. The percolates are evaporated to dryness. Extract of cascara is difficult to powder if evaporated directly to dryness in open pans, but if the extract while still soft is introduced into a vacuum pan and rapidly pumped up, it rises in the form of bubbles, which permit the ready escape of vapour. It is important not to let the vacuum run down, or the bubbles collapse.

Yield from 20 to 23 per cent.

NOTE.—Extract prepared from fresh cascara bark frequently occasions unpleasant symptoms, hence the necessity for keeping it some time before use, the usual period being two to four years.

Extractum Kramerice.—Krameria, in coarse powder, is exhausted in the same way as cascara, the resulting percolates being evaporated to dryness. The operation must be carried out in copper or tinned pans, any trace of iron blackening the extract.

Yield from 15 to 18 per cent., principally krameria-tannin and krameria-red, a decomposition product of the first named.

Semi-solid or Soft Watery Extracts

Extractum Anthemidis.—Chamomiles are exhausted by successive macerations or percolations with boiling water, the resulting liquors being evaporated to the consistence of a soft extract. As most of the volatile oil is dissipated during evaporation, a small quantity is afterwards added to give the product a more characteristic odour.

Yield from 35 to 38 per cent.

Extractum Gentianæ.—The crushed root is directed to be infused with ten times its weight of boiling water, and the strained infusion evaporated to the consistence of a semi-solid extract. This is a decidedly wasteful process, as the drug is not by any means exhausted. It is customary, therefore, to percolate the crushed root with boiling water until practically exhausted, when the liquors are evaporated in the usual way.

Yield by the latter process about 50 per cent.

Extractum Glycyrrhizæ.—Liquorice root, peeled and crushed, is directed to be treated with two prolonged macerations with a very limited quantity (two and a half times its weight) of distilled water and pressed. The expressed liquid is heated to 100° C. to coagulate albuminous matter, strained through flannel, and evaporated to the consistence of a soft extract.

This treatment does not exhaust the root, and it is usual to percolate until exhausted.

Yield by the latter process about 30 per cent., consisting of glycyrrhizin, sugar, etc. Glycyrrhizin is a compound of glycyrrhizic acid and ammonia, and as some free acid is always present it would appear better pharmacy to add ammonia to the menstruum. Glycyrrhizic acid is almost insoluble in water alone.

Extractum Opii.—Opium is cut into small pieces and exhausted by repeatedly macerating in cold water and pressing. The mixed and strained expressed liquids are then evaporated to a soft extract.

Assayed as described under Opium, 7 grammes being used for the test, extract of opium should yield 20 per cent. of morphine.

Alcoholic Extracts

Extractum Belladonnæ Alcoholicum (standardised)

- „ *Cannabis Indicæ*
- „ *Colocynthis Compositum*
- „ *Ergotæ*
- „ *Euonymi Siccum*
- „ *Jalapæ*
- „ *Nucis Vomicæ* (standardised)
- „ *Physostigmatis*
- „ *Rhei*
- „ *Stramonii*
- „ *Strophanthi*

Extractum Belladonnae Alcoholicum.—This is prepared from the standardised liquid extract, which contains 0.75 per cent. alkaloid. Four fluid parts are evaporated to a thin extract and mixed with sufficient finely powdered milk sugar to produce three parts by weight. This generally gives a brown, partially coherent powder, which on exposure loses water and gains in alkaloidal strength. The almost universal procedure is to evaporate to dryness. Extracts, moreover, containing a powder of the nature of milk sugar are not suitable for the preparation of plasters, etc., and it is customary in such cases to diverge slightly from the official directions (*vide* Emplastrum Belladonnæ).

Alcoholic extract of belladonna contains 1 per cent. of alkaloid, chiefly consisting of atropine.

Belladonna root of fair quality yields from 0.3 to 0.6 per cent. of alkaloid.

Extractum Cannabis Indicae.—Indian hemp, in coarse powder, is exhausted by percolation with 90-per-cent. alcohol; the percolate is then placed in a still and the spirit drawn off, leaving behind a soft resinous extract. As little heat as possible should be employed, as the resins suffer decomposition and do not completely redissolve in alcohol after exposure to high temperatures.

Yield from 12 to 17 per cent.

Extractum Colocynthis Compositum.—In the manufacture of this compound extract, the colocynth pulp is first exhausted by maceration with 60-per-cent. alcohol, the latter being recovered by distillation. The yield is from 30 to 40 per cent.

The simple colocynth extract is then mixed with the extract of aloes, soap, and scammony resin, and evaporated to a firm extract, the powdered cardamoms being added towards the end of the process.

Custom requires this preparation to be sent out in the form of powder.

Extractum Ergotæ (Ergotin).—Ergot, in moderately fine powder (No. 40), is exhausted by percolation with 60-per-cent. alcohol, the alcohol recovered at a temperature not exceeding 75° C., and the residue evaporated to a low bulk—one part by measure being equivalent to about four parts by weight of ergot. An equal volume of water is then added to throw out oily matters, which are removed by filtration, a little kieselguhr being added to expedite the process. The filtrate and washings are next mixed with dilute hydrochloric acid, which causes a further precipitate of inert matter, filtered, neutralised by the addition of sodium carbonate, and evaporated to the consistence of a soft extract.

Yield from 20 to 24 per cent. The *water-soluble* extract varies

from 13 to 15 per cent. It is important not to exceed the temperature mentioned, as ergot is peculiarly susceptible to heat.

Extractum Euonymi Siccum (Euonymin).—Coarsely powdered euonymus bark is exhausted by percolation with 45-per-cent. alcohol, the alcohol recovered, and the residue evaporated to dryness, when it is mixed with one-fourth its weight of calcium phosphate.

Extract of euonymus is very hygroscopic and difficult to preserve in the dry state, hence the addition of an absorbent powder. A better preparation, and one less liable to take up water, is obtained by evaporating the liquid to a thin extract, determining the extractive present in an aliquot part, adding the calcium phosphate, and evaporating the mixture to dryness. Not only is the resulting powder less hygroscopic, but there are no white particles visible in the finished powder. It should be preserved in well-sealed bottles.

Yield from 15 to 20 per cent.

Extractum Nucis Vomicae.—This extract is prepared in a similar way to *Extractum Belladonnæ Alcoholicum*—that is, it is made from a standardised liquid extract. *Extractum Nucis Vomicae Liquidum* contains 1·5 parts of strychnine in 100 fluid parts, and as the extract is required to contain 5 per cent. of strychnine it follows that fifty parts of the liquid must be made to weigh fifteen parts to accord with this. Milk sugar is again the diluent, and, as in the former case, it yields a far from satisfactory preparation. If the liquid extract has been prepared from rich seed, the finished extract may be so thin that the milk sugar will sink, leaving the upper layer of extract correspondingly stronger. This being the case, it is usual to evaporate to dryness. An alternative method would be to use extract of taraxacum or similar harmless extract as a diluent.

Extract of nux vomica should contain 5 per cent. of strychnine.

Extractum Physostigmatis.—The powdered Calabar beans are exhausted by percolation with 90-per-cent. alcohol, the alcohol recovered, and the resulting soft extract weighed when cold; it is then carefully mixed with three times its own weight of milk sugar. The milk sugar is added as a diluent to bring the dose within the usual range.

Yield about 25 per cent.

Extractum Rhei.—The bruised rhubarb root is percolated with 60-per-cent. alcohol until exhausted, the alcohol recovered by distillation, and the extract evaporated to dryness and powdered.

Yield from 40 to 45 per cent. ●

Extractum Stramonii.—Prepared by percolating ground seeds with

70-per-cent. alcohol, recovering the alcohol by distillation, and evaporating the residue to the consistence of a firm extract.

Yield about 7 per cent.

Extractum Strophanthi.—Strophanthus seeds, in No. 30 powder, are placed in a water-oven, and the moisture driven off at a temperature not exceeding 43° C. When *perfectly dry* the material is packed in a percolator and percolated with 0·717 methylated ether until free from fat and resin. The marc, after heating to about 48° C. to dissipate the ether, is powdered, again packed in the percolator, and exhausted with 90-per-cent. alcohol. The alcohol is recovered by distillation, the extract removed to a counterpoised dish and weighed, sufficient milk sugar being incorporated to produce two parts by weight of powdered extract from each part of seeds operated upon.

Yield.—The extractive matter yielded to 70-per-cent. alcohol (the strength prescribed for Tinctura Strophanthi) varies from 14 to 20 per cent. ; alcohol of 90 per cent. extracts considerably less, although apparently an equally good solvent for the strophanthin, which varies from 2 to 6 per cent.

Extractum Jalapæ.—This is a rather peculiar extract, inasmuch as the ground jalap is first extracted with 90-per-cent. alcohol, which removes the resin, and then treated with water, which only removes gum, sugar, and other inert matter, the extracts which result after removal of the solvents being afterwards mixed. The extracts do not mix well, and the finished preparation cannot be regarded as satisfactory from a pharmaceutical point of view.

Yield of Resin varies from 6 to 11 per cent.

Evaporated Plant Juices

Extractum Belladonnæ Viride

„ Colchici

„ Hyoscyami Viride

„ Taraxaci

NOTE.—The yield of extract varies according to the age of the plants, whether the season is dry or wet, etc.

Extractum Belladonnæ Viride.—Green extract of belladonna is one of the most popular of the official extracts. The fresh leaves and young branches are crushed in a stone mortar, or on a large scale between granite rollers or in an edge-runner mill (contact with iron is to be avoided), the juice pressed out and heated to 54° C. The green colouring matter (chlorophyll) separates and is strained out and reserved. The brown-coloured liquid is then heated to 94° C., when

the albumin coagulates and is strained out and rejected. The clear liquor is next evaporated at a temperature below 100° C. to a thin extract, when the reserved chlorophyll is strained in through a hair sieve and evaporation continued, at a temperature below 60° C., to a soft extract.

The chlorophyll appears to exercise a preservative or protective action, as an extract free from chlorophyll is more hygroscopic and prone to mould.

Yield of expressed Juice, from 60 to 65 per cent. ; of Extract, from 3·3 to 4·3 per cent.

Average yield of alkaloid in the extract, 0·75 to 1·2 per cent.

It is important to work the plants as soon as possible after cutting, as, if they are at all wilted, scarcely any chlorophyll can be pressed out. The leaves lose about 84 per cent. of moisture in drying.

Extractum Colchici.—Fresh colchicum corms are washed, deprived of their coats, and crushed as described above. The pressed juice is allowed to stand for the feculence (starch, etc.) to deposit, the decanted liquor being afterwards heated to 100° C. to coagulate the albumin. This is strained out, and the clear liquor evaporated at a temperature below 70° C. to the consistence of a soft extract.

Yield of Extract, from 3·8 to 4 per cent., which contains an average of about 1·5 per cent. of colchicine.

Extractum Hyoscyami Viride.—This is prepared from the fresh leaves, flowering tops, and young branches of henbane in a similar way to that described under *Extractum Belladonnæ Viride*.

Yield of expressed Juice, 60 to 76 per cent. ; of Extract, from 3·5 to 5 per cent. The leaves lose nearly 90 per cent. of moisture in drying.

Extractum Taraxaci.—Dandelion roots, collected in the autumn, are washed and treated exactly as described under *Extractum Colchici*. The feculence mentioned is due to inulin, a substance resembling starch.

Yield of Juice, from 45 to 50 per cent. ; of Extract, from 8 to 10 per cent.

Fel Bovinum Purificatum.—Purified ox bile, although not strictly speaking an extract, may be conveniently considered here. The fresh contents of the gall-bladder of the ox are evaporated to one-fourth the original bulk, cooled, and mixed with 90-per-cent. alcohol. The precipitated mucous matter is separated by filtration, and the clear liquor evaporated to the consistence of a thick extract.

Yield from 7 to 10 per cent., consisting chiefly of the sodium salts of taurocholic and glycocholic acids, and cholesterin.

Liquid Extracts

The liquid extracts may be classified as follows :

Aqueous Liquid Extracts

Extractum	Cascaræ	Sagradæ	Liquidum
„	Cinchonæ		Liquidum (standardised)
„	Ergotæ	„	
„	Glycyrrhizæ	„	
„	Opii	„	(standardised)
„	Pareiræ	„	

Extractum Cascaræ Sagradæ Liquidum.—Coarsely-ground two or three year old cascara is exhausted by percolation with cold water, and the clear percolate concentrated in an open or vacuum pan until sixty parts of liquid represent 100 parts by weight of the original drug. After cooling, forty fluid parts of 45-per-cent. alcohol are added, and the mixture is set aside to deposit.

Specific Gravity, 1·060 to 1·080 ; *Extractive*, 24 to 26 per cent. ; *Alcohol by volume*, 17 to 18·5 per cent.

NOTE.—In very hot weather the alcohol requires to be made up to at least 20 per cent. by volume to prevent fermentation.

Extractum Cinchonæ Liquidum.—Cinchona bark is exceedingly difficult of exhaustion on account of the insolubility of the natural salts present—probably quimates and cinchotannates of the various alkaloids. Water alone is a very poor solvent, and alcohol is not much better. The pharmacopœial plan of exhausting with a mixture of very dilute hydrochloric acid and glycerin gives fair results, but does not by any means remove the whole of the alkaloid. The best results are obtained by mixing the acid and glycerin with sufficient distilled water to form a thin sludge with the cinchona, which should be in No. 60 powder, and macerating for several weeks, stirring at intervals. The mixture is then transferred to one or more earthenware or wooden percolators, and percolation continued with distilled water until the droppings practically cease to give a white precipitate with caustic alkali. The percolate is meanwhile evaporated in an earthenware or enamelled vessel at a temperature not exceeding 82° C. until each fluid part represents one part by weight of cinchona. *The Pharmacopœia directs that the bark shall contain 5 per cent. of total alkaloids, at least half being quinine.*

Assay process.—The proportion of alkaloid present is determined by alkalisising with caustic potash and extracting with a mixture of benzol and amyl alcohol, in which the alkaloids are freely soluble. The ethereal liquid is then in turn extracted with dilute hydrochloric acid, the alkaloids being removed as hydrochlorides. From this last

solution they are precipitated with ammonia and shaken out with chloroform, which on evaporation leaves them sufficiently pure for weighing.

Take of the Concentrated Percolate	5 c.c.
Distilled Water	25 c.c.
Benzolated Amylic Alcohol	25 c.c.
Solution of Potash	15 c.c.

Mix in a separator, shake vigorously for twenty minutes, and allow to rest until separation takes place. Draw off the dark alkaline layer into a flask and preserve; draw off the alcoholic layer into another flask, cork, and set aside.

Return the alkaline solution to the separator, and repeat the agitation with a further 25 c.c. benzolated amylic alcohol; separate and draw off as before.

Place the mixed alcoholic solutions of alkaloids again in the separator and shake with a few c.c. distilled water; separate, and draw off the wash-water.

Add to the contents of the separator

Dilute Hydrochloric Acid	5 c.c.
Distilled Water (about 80° C.)	25 c.c.

Shake vigorously; separate and draw off the acid, which contains most of the alkaloids as hydrochlorides.

Repeat the treatment with a further quantity of acid and water. To the mixed acid solutions add

Chloroform	10 c.c.
Sol. of Ammonia 0.959 - sufficient to make distinctly alkaline	

Shake vigorously and allow to separate; draw off the chloroformic solution of the alkaloids into a counterpoised dish. Repeat the agitation with two further quantities of 10 c.c. each of chloroform, and add to that already in the tared dish. Allow the chloroform to evaporate, finally drying the alkaloids at a temperature of about 110° C.

The weight of the alkaloids multiplied by twenty gives the percentage, or, rather, the grammes per 100 c.c.

Having ascertained the alkaloidal strength of the original concentrated percolate, every measure of it containing five parts by weight of alkaloid must be brought to $87\frac{1}{2}$ fluid parts either by dilution with water or by concentration, and mixed with $12\frac{1}{2}$ fluid parts of 90-per-cent. alcohol. The finished liquid extract will then contain 5 grammes of total alkaloids in 100 c.c. As this liquid extract continues to deposit for some time after manufacture, it should not be filtered at once.

Example.—It was found by experiment that 5 c.c. of the strong percolate yielded 0.244 gramme of mixed alkaloid, therefore 102.5 c.c. will contain 5 grammes. Every 102.5 parts by volume must therefore be concentrated to $87\frac{1}{2}$ volumes and mixed with $12\frac{1}{2}$ volumes of 90-per-cent. alcohol.

Extractum Ergotæ Liquidum.—Ergot, in coarse powder, is exhausted by maceration and percolation with cold water, the percolate evaporated at a temperature not exceeding 75° C. (preferably in a vacuum pan) until fourteen parts by volume correspond to twenty parts by weight of ergot originally taken. The concentrated liquor is then allowed to cool, mixed with the alcohol, and after twenty-four hours filtered.

In warm weather the percolate soon decomposes, and it is advisable to use *chloroform* water as a menstruum. As the chloroform is all dissipated during concentration, the liquid extract is strictly pharmacopœial.

Specific Gravity, 1.015 to 1.027; *Extractive*, 13 to 16 per cent.; *Alcohol by volume*, 31.4 to 32.2 per cent.

Extractum Glycyrrhizæ Liquidum.—Ground, decorticated root is percolated with cold water until exhausted, the percolate heated to 100° C., and strained to remove the coagulated albumin. The clear liquor is then evaporated (preferably in a vacuum pan) until it has, when cold, a specific gravity of 1.200, when it is mixed with one-fourth its volume of 90-per-cent. alcohol and, after standing, again filtered.

Specific Gravity, 1.115 to 1.150; *Extractive*, 39 to 44 per cent.; *Alcohol by volume*, 16 to 17.7 per cent.

As previously remarked under *Extractum Glycyrrhizæ*, an improvement would be effected by adding a small quantity of solution of ammonia to the water; not only would this give a better yield, but the resulting liquid extract would be more miscible.

Extractum Opii Liquidum.—This is prepared from the standardised solid extract, by dissolving 0.75 part in sixteen fluid parts of distilled water, mixing with four fluid parts of 90-per-cent. alcohol, and filtering after standing for some time. If necessary the filter should be washed with sufficient distilled water to produce twenty fluid parts.

Assayed as described under *Tinctura Opii*, this liquid Extract should contain not less than 0.7 and not more than 0.8 gramme of morphine in 100 c.c.

Specific Gravity, 0.985 to 0.995; *Alcohol by volume*, 17 to 18 per cent.

Extractum Pareiræ Liquidum.—The crushed root is exhausted by maceration and percolation with boiling water, the percolate evaporated

until it contains $33\frac{1}{3}$ parts by weight of extractive in 100 fluid parts, when it is cooled ; every three volumes is then mixed with one volume of 90-per-cent. alcohol, set aside to deposit, and filtered.

Specific Gravity, 1.030 to 1.060 ; *Extractive*, 18 to 22 per cent. ; *Alcohol by volume*, 20 to 22 per cent.

Alcoholic Liquid Extracts ¹

Extractum Belladonnæ Liquidum (standardised)		
„	Cimicifugæ	„
„	Cocæ	„
„	Hamamelidis	„
„	Hydrastis	„
„	Ipecacuanhæ	„ (standardised)
„	Jaborandi	„
„	Nucis Vomiceæ	„ (standardised)
„	Sarsæ	„
„	Taraxaci	„

Extractum Belladonnæ Liquidum.—This liquid extract is prepared by repercolation, a process devised for exhausting drugs with the least possible quantity of menstruum. Examination of the formula will show that the active principles of 100 parts of root have to be got into about forty fluid parts, and this without the employment of heat. The reason for preparing so concentrated a liquid extract is that *good root* only averages about 0.45 per cent. of alkaloid, and as this cannot be all extracted by the official process, *at least* two parts of root must be treated to obtain one part of liquid extract.

Preparation of a concentrated liquid extract by repercolation.—Any convenient quantity of root, in No. 20 powder, is divided into four equal portions. The *first* portion is damped with 80-per-cent. alcohol, packed in a percolator, and, a sufficiency of menstruum having been added, is set on one side. When as many fluid parts of percolate have collected as there are parts of root in the percolator, it is removed and used to moisten the *second* portion of belladonna. Meanwhile the first percolator is kept supplied with menstruum, the resulting percolate being used to complete the exhaustion of the second portion of root. The percolate from the second percolator is next used for the *third* portion, and the percolate from this is finally used for the *fourth* portion. By this apparently complicated, but really very simple, process the whole of the menstruum is made to pass through each percolator *in turn*, the resulting liquid extract

¹ It has been shown by Farr and Wright that most drugs are exhausted by percolation with appropriate menstrua in the proportion of one of drug to three of liquid. In the case of *nux vomica* the first one-in-one percolate actually contained 80 per cent. of the total alkaloid.

receiving regular augmentations of strength, until at the last it is sufficiently concentrated for the purpose.

The contents of the percolators are nothing like exhausted by the above process, and it is customary to continue repercolating until the droppings from the last percolator run through nearly colourless. All four marcs are then pressed, the alcohol distilled from the press-cakes, and the mixed liquids set on one side for the next batch.

The diagram (fig. 138) shows how such a series of percolators may be linked up.

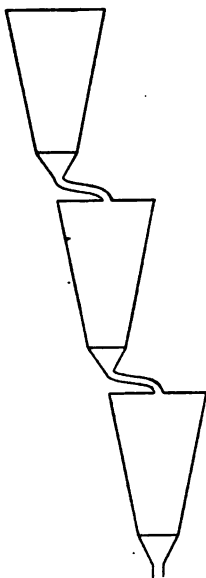


FIG. 138.

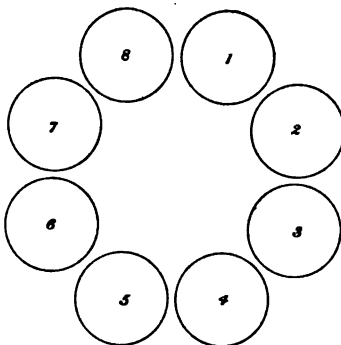


FIG. 139.

On a large scale the percolators are arranged in a row or in a circle, there being perhaps eight units in a battery (fig. 139). Each percolator is charged with an equal weight of drug. Menstruum is poured into No. 1, the percolate being made to traverse each unit in turn until it passes through No. 8. Menstruum having been constantly supplied to the first unit, by the time No. 8 commences to run the first is generally exhausted. It is then emptied, the marc pressed, and the percolator charged with fresh drug, when it will become the *last* percolator. This process of cutting out the first percolator and making each in turn the *last*, proceeds without interruption, the manufacture thus being continuous.

NOTE.—Belladonna root varies greatly in alkaloidal value—0·3 to 0·6 per cent.—but it should not be used much below 0·4 per cent., or the resulting liquid extract will prove too dark for many pharmaceutical preparations.

Assay process.—The official process as it stands is very troublesome to follow, as the addition of caustic alkali to the *oil* liquid

extract forms a soap which tends to produce an emulsion with the chloroform. The following modification is therefore generally employed :

Introduce into a separator

10 c.c. of the Concentrated Liquid Extract
 50 c.c. of Chloroform-water
 2 c.c. of Dilute Sulphuric Acid
 10 c.c. of Petroleum Ether

The mixture is violently shaken and set aside until separation takes place, when the ethereal oily layer is removed. A second treatment with 5 c.c. more petroleum ether suffices to remove the last traces of fat.

The mixture is then made distinctly alkaline with ammonia and extracted by shaking with three successive portions of 10 c.c. each of chloroform ; the three chloroformic solutions of the alkaloids are next mixed and washed with 1 c.c. chloroform-water, separated, and set on one side in a beaker for the chloroform to evaporate. If the operation has been carefully carried out, the alkaloid, consisting of a mixture of hyoscyamine and atropine, will be found distinctly crystalline.

10 c.c. $\frac{N}{10}$ HCl is then added to the alkaloid in the beaker, gently warmed to promote solution, and titrated back with $\frac{N}{100}$ KOH, using *freshly made* tincture of cochineal as indicator.

Each c.c. of $\frac{N}{10}$ HCl in combination with the alkaloid corresponds to 0.0287 gramme of alkaloid.

$$\frac{C_{17}H_{23}NO_3}{287.05} = 1 \text{ litre } \frac{N}{1} \text{ HCl, containing 36.19 grammes HCl}$$

$$\therefore 1 \text{ c.c. } \frac{N}{1} \text{ HCl} = 0.28705 \text{ gramme alkaloid}$$

$$\therefore 1 \text{ c.c. } \frac{N}{10} \text{ HCl} = 0.0287 \text{ gramme alkaloid}$$

The strength of the liquid extract having been found, it must be diluted so that 100 fluid parts shall contain 0.75 part by weight of alkaloid.

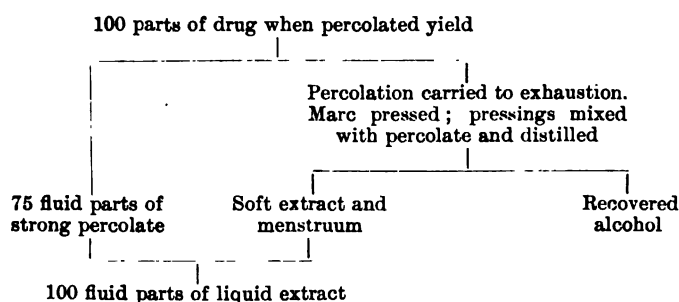
Example.—Supposing the alkaloid from 10 c.c. strong percolate after dissolving in 10 c.c. $\frac{N}{1}$ HCl required 70 c.c. $\frac{N}{100}$ KOH for neutralisation, it follows that 3 c.c. $\frac{N}{10}$ HCl must be in combination with the alkaloid (10 c.c. $\frac{N}{10}$ HCl = 100 c.c. $\frac{N}{100}$ KOH). Each c.c. of $\frac{N}{10}$ HCl then being

equivalent to 0.0287 gramme alkaloid, $0.0287 \times 3 = 0.0861$ is the amount of alkaloid present in 10 c.c. of strong percolate. This weight multiplied by 10 gives the parts by weight in 100 fluid parts.

87.1 parts by volume must then be diluted with alcohol 80 per cent. to 100 parts ($\frac{100 \times 0.75}{0.861} = 87.1$).

The specific gravity and alcoholic strength of the finished liquid extract vary, but the average comes out somewhat as follows :
Specific Gravity, 0.900 ; *Alcohol by volume*, 73 per cent.

Extractum Cimicifugæ Liquidum.—This liquid extract is prepared on general lines, and may be considered at the same time as the *Liquid Extracts of Coca, Hamamelis, Hydrastis, and Jaborandi*. The drugs, in the required state of comminution, are exhausted by percolation with the respective alcoholic menstrua, one fluid part of the finished liquid extract representing one part by weight of the original drug. To obtain this result 100 parts of drug are percolated until seventy-five fluid parts of percolate have been collected. This liquid, which may be taken as containing most of the active constituents and odorous principles, is reserved, percolation then being continued until the drug is exhausted. The second percolate and the pressings are transferred to a still, the alcohol recovered by distillation, and the resulting liquid extract evaporated to a soft extract, which, after cooling, is dissolved in the reserved portion, and the whole made up to 100 fluid parts with menstruum. This process, which is a general one employed for the preparation of many liquid extracts other than the official ones, may be illustrated by a diagram as follows :



Yields	Specific Gravity	Extractive (grammes per 100 c.c.)	Alcohol Percentage by volume
<i>Extractum Cimicifugæ Liquidum</i>	0.880–0.900	10–12	75–78
„ <i>Cocæ</i> „	1.000–1.010	16–20	45–50
„ <i>Hamamelidis</i> „	1.026–1.050	20–22	33–34
„ <i>Hydrastis</i> „	1.025–1.040	20–22	37–39
„ <i>Jaborandi</i> „	1.020–1.045	20–22	33–34

Extractum Ipecacuanhæ Liquidum.—This standardised liquid extract is prepared in a similar manner to the five just considered, but with this modification—after the first percolate has been collected and set on one side, slaked lime is mixed with the drug before proceeding to exhaustion. The alkaloids of ipecacuanha are only removed with considerable difficulty with 90-per-cent. alcohol, and an attempt is made to set them free by addition of the lime. The final result is not very good, much alkaloid remaining unextracted. With 60-per-cent. alcohol as menstruum practically all the alkaloid is removed, and the use of lime is rendered unnecessary.

Assay process.—The official process is difficult to carry out, but following the modifications suggested by Bird the time is much shortened and the results rendered more accurate.

10 c.c. of the strong percolate is mixed with 10 c.c. of water and rendered faintly acid with acetic acid. After evaporation of the alcohol, 5 c.c. Liquor Plumbi Fortis mixed with 10 c.c. more water is added, and the mixture heated on a water-bath until the precipitate becomes granular.

Meanwhile a 'Buchner funnel' is covered with a closely fitting filter-paper and coated by adding a mixture of kieselguhr and water. The treated extractive is then drawn through the prepared filter by means of a filter-pump, and the residue very carefully washed with 15 c.c. of water.

12.5 c.c. of dilute sulphuric acid is added to the filtrate, and the mixture filtered by means of a pump as before, the cake being washed with 10 c.c. of water.

The filtrate, now containing the alkaloids as sulphates, is made distinctly alkaline with ammonia and extracted in a separator with three portions of 10 c.c. each of chloroform. The chloroform is evaporated gently to about 2 c.c., when 5 c.c. of ether 0.717 is added and the contents of the dish are kept continually rotated until the solvent has all evaporated, when the dish is placed in a drying-oven and heated to 80° C. until dry.

From the weight obtained, the amount of alkaloid in the strong percolate is calculated, 90-per-cent. alcohol being added so as to produce a liquid extract containing not less than 2.0 and not more than 2.25 grammes of alkaloid in 100 c.c.

Example.—If 10 c.c. yielded 0.245 gramme alkaloid, 100 c.c. will contain 2.45 grammes. Therefore every 85.7 fluid parts must be diluted to 100 fluid parts to form a liquid extract containing an average of 2.1 grammes in 100 c.c. $\left(\frac{100 \times 2.1}{2.45} = 85.7 \right)$.

Extractum Nucis Vomice Liquidum.—The official process for the preparation of this liquid extract is exhaustion by percolation

with 70-per-cent. alcohol, the first strong percolate being reserved, the later portions concentrated, and the residual extract dissolved in the reserved portion, which is then assayed. This method yields an extract containing fat, and the process followed by manufacturers on a large scale will therefore be described.

The Seeds, in about No. 20 powder, are exhausted by *repercolation* as described at length under *Extractum Belladonnæ Liquidum*, 70-per-cent. alcohol being used as menstruum. The resulting liquid extract is then placed in a closed vessel with about 2 or 3 per cent. of hard paraffin and heated to 60° C. for a few minutes, being violently agitated meanwhile. The vessel is then allowed to rest and cool, when, a hole having been made in the oily cake which will be found to have formed at the top, the liquid may be drawn off practically fat-free. This procedure is generally adopted because *nux vomica* seeds, which contain 4 to 5 per cent. of fat, are so often rancid and yield unpleasant smelling extracts.

Assay process.—The pharmacopœial process is very tedious and yields somewhat discordant results, and a process which will be described later is almost invariably employed in its stead. The official assay process, with slight modification, is as follows :

10 c.c. of the strong percolate is warmed over a water-bath to drive off the alcohol ; 10 c.c. of warm water and a few drops of dilute sulphuric acid are added and the whole transferred to a separator. The dish is rinsed out with 10 c.c. more warm water and finally with 10 c.c. of chloroform. The contents of the separator are then shaken *gently*, allowed to separate, and *the chloroformic layer containing the last traces of fat is drawn off.*

Five grammes sodium carbonate dissolved in 25 c.c. of warm water is next added, and the contents again shaken with 10 c.c. of chloroform and set aside to separate. *The chloroformic solution of alkaloids is drawn off and reserved.*

Extraction is twice repeated (**), and the three chloroformic solutions are placed in a clean separator with a mixture of 2 c.c. of dilute sulphuric acid and 8 c.c. of warm water. The contents are again shaken, separated, and *the acid solution, containing sulphates of the alkaloids, is drawn off and reserved.* This extraction with acid and warm water is repeated twice.

The mixed acid solutions are next diluted to 175 c.c. in a stoppered flask containing 25 c.c. of 5-per-cent. potassium ferrocyanide solution, shaken well and frequently during half an hour, and then set aside for at least six hours. In this time *strychnine ferrocyanide is precipitated*, brucine ferrocyanide remaining in solution.

The contents of the flask are transferred very carefully to a small filter, the last portions being rinsed out and the precipitate washed with not more than 50 c.c. of sulphuric acid (1 in 250). *The strychnine*

ferrocyanide is readily decomposed, and were the contents of the filter washed until free from bitterness, as prescribed by the Pharmacopœia, there would be nothing left.

The precipitate is next washed into a separator with distilled water, 5 c.c. of ammonia solution (0.959) and 10 c.c. of chloroform added, and the mixture well shaken. The chloroformic layer, containing the strychnine, is drawn off, the extraction being repeated with 5 c.c. more chloroform. The mixed chloroformic solutions are allowed to evaporate spontaneously in a wide-mouthed flask, the residue damped with pure amylic alcohol and dried on a water-bath until the weight remains constant. *If the addition of amylic alcohol to the nearly dry crystals is omitted, they will decrepitate, much loss being occasioned by spurting.*

From the weight obtained, the amount of strychnine present in the strong percolate is calculated, sufficient 70-per-cent. alcohol being added to produce liquid extract of nux vomica containing 1.5 grammes of strychnine in 100 c.c.

Example.—Supposing 10 c.c. of the strong percolate yielded 0.176 gramme strychnine, then 100 c.c. will yield 1.76 gramme. Every 85.2 fluid parts must therefore be diluted to 100 fluid parts with 70-per-cent. alcohol ($\frac{100 \times 1.5}{1.76} = 85.2$).

Although the Pharmacopœia does not require the alkaloid to be titrated, it is strongly recommended that the result be *checked* by this method. 10 c.c. of $\frac{N}{10}$ H_2SO_4 should be run on to the alkaloid and, as soon as solution is perfect, titrated back with $\frac{N}{100}$ KOH, using cochineal as indicator. Each c.c. of $\frac{N}{10}$ H_2SO_4 in combination corresponds to 0.0331 gramme of strychnine.

Nux vomica seeds contain, as a rule, from 0.75 to 1.5 per cent. of strychnine. The brucine is very variable, ranging from 1 to 2 per cent. Rarely is the percentage of brucine less than that of the strychnine.

Alternative process by nitric acid (this is not official, but is more accurate).—Ten c.c. of the strong percolate is treated as prescribed in the official assay process as far as obtaining of alkaloid in 30 c.c. of chloroform (**page 145). The mixed chloroformic solutions are then extracted with three portions (each 16 c.c.) of 2-per-cent. sulphuric acid.

5 c.c. of nitric acid sp. gr. 1.42 is added, and the mixture set aside for fifteen minutes. *This destroys the brucine, but does not affect the strychnine.*

Excess of ammonia having been added, and the alkaline solution

transferred to a separator, the strychnine is extracted by shaking with three separate portions (10 c.c. each) of chloroform, the mixed chloroformic solutions being afterwards washed with a mixture of 1 c.c. of ammonia and 44 c.c. of water, divided into three portions.

The chloroformic solution is then transferred to a wide-mouthed flask and evaporated to low bulk, when 2 c.c. of amylic alcohol is added and the crystals dried slowly at 100° C.

This process is not only much quicker than the official one, but the results are more concordant, and it can also be applied without difficulty to the solid extract and to the tincture of nux vomica.

The *Specific Gravity* ranges from 0.950 to 0.965; *Extractive*, from 11 to 13 per cent.; *Percentage of Alcohol by volume*, from 58 to 61.

Extractum Sarsæ Liquidum.—Sarsaparilla in powder, preferably not finer than 30 hole, is exhausted by *repercolation* with 20-per-cent. alcohol, the percolation being so managed that ninety fluid parts finally represent 100 parts of drug; ten fluid parts of glycerin are then added.

Specific Gravity, 1.070 to 1.090; *Extractive before addition of glycerin*, 18 to 24 per cent.; *Percentage of Alcohol by volume*, 16 to 18.

Extractum Taraxaci Liquidum.—This is a somewhat peculiar liquid extract, the root in coarse powder being first macerated with 60-per-cent. alcohol (the pressings being reserved), and then with a large bulk of water, and again pressed. The aqueous pressings are concentrated and mixed with the alcoholic portion.

Specific Gravity, 1.050 to 1.080; *Extractive*, 24 to 26 per cent.; *Percentage of Alcohol by volume*, 23 to 26.

The only remaining liquid extract to be considered is that of male fern—

Extractum Filicis Liquidum.—The rhizome, in coarse powder, is exhausted with ether in a specially constructed percolator, the ether recovered from the percolate by distillation, and the residual oily extract heated in an open pan until the odour of ether disappears. The product is of a complex character, containing filicic acid, aspidin, and many other substances.

Specific Gravity from 1.001 to 1.020; *Yield*, 12 to 15 per cent.

Extractum Malti.—Although extract of malt is not at present included in the Pharmacopœia, it is felt that a short description of the method of manufacture will not be out of place. Two varieties are commonly produced, one rich in maltose and the other rich in dextrin. For a long time it was assumed that malt extract when taken with starchy foods was an aid to digestion, consequently malt extract containing the highest proportion of diastase was the greatest desideratum. Experience showed that extracts of this class did not

keep well, the maltose frequently crystallising on keeping, and scientific investigation has proved that no matter how high the amylolytic action of any given extract, when tested under laboratory conditions, may be, it is practically certain that the ferment is destroyed directly it comes into contact with the acid juices of the stomach. This being the case, and extract of malt now being regarded solely as a food, the aim of most manufacturers may be said to be to produce an article pleasant in appearance, acceptable to the palate, and of good keeping quality.

'Pale' malts do not yield good extracts, the maltose being so ready to crystallise; if, however, the previously dried malt is heated to about 95° C. a much better keeping article is produced, while the temperature is not sufficiently high to destroy the diastase or even to impair the colour. The malt, having been crushed between rollers, is run into the mash-tun with the water heated to about 73° C., the two passing down a shoot together, thus ensuring perfect admixture. As little water as possible is used for the first mash, which is drawn off after one and a-half to two hours; the liquor is then filter-pressed and evaporated in a vacuum pan at a temperature below 48° C.

More, and somewhat warmer, water is then added to the mash-tun, and percolation carried to practical exhaustion, the filtered liquor being evaporated *in vacuo* to a density of about 1.400 when cold. Extract prepared as above is pleasant to the taste and will dissolve its own weight of gelatinised starch in twenty minutes at the outside. Some makers add glycerin, presumably as a preservative, but no particular advantage seems to be derived from this practice.

It is most important to keep all utensils used in the 'brewery' thoroughly clean and aseptic, as once foreign germs gain a footing it is most difficult to eradicate them, and the name of moulds that exercise a deleterious effect on extract of malt is 'legion.' To prevent the candying, which in some seasons gives much trouble, there is no doubt that some makers add dextrin, as on analysis some extracts show a greater proportion of this than can possibly be accounted for by any process of mashing. Malt extract with a higher percentage of dextrin can no doubt be produced by using very hot and short mashes, with the least possible quantity of water, thus preventing the diastase from exerting its full influence. The higher temperature, however, impairs the value of the diastase.

Extracts of very high diastasic power are made by mashing first with *tepid water*, the liquor, after drawing off, being filtered and set aside. The mash-tun is then filled with *boiling water*, the percolate drawn off, filtered, and evaporated rapidly at a fairly high temperature. The vacuum pan is afterwards cooled down and the reserved portion added, evaporation being continued at about 46° to 48° C. until the extract is of the right consistence. It will be seen that during this

second evaporation the diastase is acting under the most favourable conditions.

It has also been suggested to make an extract with 'green malt,' which is afterwards added to extract prepared under the ordinary conditions.

Very complete details for the testing of malt extracts were published by Harrison ('Year-book of Pharmacy,' 1906, page 278), and should be consulted by those interested in the subject. The following table shows the great variation in composition of commercial samples :

—	Total Solids per cent.	Maltose per cent.	Proteids per cent.	Diastasic Value	Remarks
1	73·2	65·4	6·7	468	—
2	79·8	64·4	5·3	346	—
3	69·8	58·5	5·5	356	—
4	77·0	54·0	3·6	10	—
5	72·3	52·1	3·8	15	—
6	95·9	82·1	5·7	89	A solid extract.
7	76·8	66·0	6·1	96	Contained salicylic acid.
8	74·3	62·5	6·1	65	Contained salicylic acid.
9	73·0	47·1	3·8	17	Contained cane sugar.
10	66·2	49·7	3·9	0	—
11	78·7	74·2	5·5	268	—
12	64·9	58·8	3·9	0	—
13	73·9	63·6	6·6	137	—

Oleo-resins

In addition to the extracts just described, there is another class, of which extract of male fern (*q.v.*) is the only official example—the oleo-resins. They consist of resinous bodies associated with volatile and fixed oils, and are obtained by percolating the ground drug with ether, carbon tetrachloride, acetone, or other suitable solvent. The apparatus is generally so arranged that the solvent may be recovered from the percolate as well as the exhausted marc without disconnecting.

Oleo-resina Capsici.—The commercial article is extremely variable, and generally deposits fat or wax on standing. The yield, which should be a reddish-brown liquid, varies from 8 to 14 per cent.

Oleo-resina Cubeæ.—Although 95-per-cent. alcohol appears to extract all the medicinal principles of cubebs, it is usual to employ a mixture of alcohol and ether, or acetone. The product varies from 19 to 26 per cent. The oleo-resin is generally brownish-green, and, like the former, deposits waxy and other matters on standing, from which the clear liquid should be decanted.

Oleo-resina Piperis.—This is generally prepared with acetone. The product is a dark-brown or blackish liquid. On keeping, crystals of piperin are deposited. The yield averages 5 per cent.

Oleo-resina Zingiberis.—The usual solvent is acetone. Natural Jamaica ginger yields from 5 to 8 per cent. of a brownish semi-liquid product, African and Cochin gingers varying even more in the yield.

Resins

Besides *Resina*, or the resin left after distillation of the oil of turpentine from the crude oleo-resin, the British Pharmacopœia recognises three medicinal resins, all of which are extracted by alcohol.

Jalapæ Resina.—This article is in much greater demand than *Extractum Jalapæ*, from which it differs in not containing any water-soluble matter. The ground drug is exhausted by percolation with 90-per-cent. alcohol (or the still stronger 'industrial spirit') after a preliminary digestion at a temperature of about 50° C. for some hours. The percolate is then mixed with water and the alcohol recovered by distillation. If the contents of the still are now allowed to cool, the resin will be found in a granular cake, which is broken up and washed with hot water to remove adhering extractive matter, and dried at a low temperature.

White jalap resin, or jalapin, is obtained by filtering the percolate through animal charcoal.

The yield of resin is variable, the raw drug differing so very much in quality, but it may be taken as from 7 to 15 per cent., although much of the jalap coming into this country fails to reach 11 per cent.

Jalap resin should be entirely soluble in 90-per-cent. alcohol, but not in oil of turpentine. Not more than 10 per cent. should be soluble in ether. This indicates absence of Tampico-jalap resin and scammony resin, although there is not much likelihood of the latter being substituted.

Podophylli Resina (Podophyllin).—This is exhausted in a similar manner to the foregoing, but after the greater part of the alcohol has been recovered by distillation, the contents of the still are allowed to cool and poured into very dilute and *very cold* hydrochloric acid, and set on one side for the resin to deposit. This is then collected, washed, and dried at a low temperature. To obtain a good colour, the water into which the extract is poured, should be ice cold—even containing floating ice—and the drying should be conducted *in vacuo*, preferably at a temperature below 30° C.

The yield varies from 3·5 to 5 per cent.

Podophyllum resin should be almost entirely soluble in 90-per-cent. alcohol and in solution of ammonia, and at least 50 per cent. should be soluble in ether. Ash not more than 1 per cent.

The podophyllin of commerce rarely corresponds to the official description.

Scammoniac Resina.—This is prepared in precisely the same way as jalap resin.

It is almost entirely soluble in ether (absence of jalap resin). It is distinguished from guaiacum resin by not giving a blue colour with ferric chloride or solution of hydrogen peroxide.

Average yield 7·4 per cent. Mexican root yields 18 per cent.

Neutral Principles, Glucosides, etc.

Aloin.—The manufacture of this article is to a certain extent a secret process. Practically, it is all derived from Curaçoa aloes and imported into this country from the United States. A moderate yield may be obtained by extracting aloes with hot water acidulated with sulphurous acid, decanting, adding hydrogen peroxide, neutralising with a little chalk, filtering under pressure through animal charcoal to partially decolourise, and freezing, when aloin crystallises out.

The aloin of commerce contains so much resinous matter that it can scarcely be regarded as more than decolourised watery extract of aloes. Yield from 20 to 40 per cent.

Chrysarobin.—On treating Goa powder with hot chloroform or other solvent and removing the liquid by distillation, a principle named chrysarobin is left behind. This generally consists of a mixture of chrysarobin and chrysophanic acid; it is purified by recrystallisation from acetic acid. Yield from 30 to 70 per cent.

Elatérin.—An exceedingly active body obtained from elaterium by extraction with chloroform, and reprecipitation with excess of ether, in which elaterin is insoluble. Yield about 30 per cent.

Salicin.—A glucoside obtained from the bark of the willow. It may be extracted with boiling water, precipitating colouring matter with basic lead acetate, treating with chalk to remove acid, the filtrate being finally forced through animal charcoal. On concentrating, salicin crystallises out.

Santonin.—Ground wormseed is mixed with hot milk of lime and filtered under pressure, the press-cakes being washed with boiling water without removing from the machine. The solution is concentrated *in vacuo*, acidulated with hydrochloric acid, the precipitated santonin dissolved in alcohol, decolourised, and recrystallised.

CHAPTER XVI

INFUSIONS AND DECOCTIONS

Infusions

As the name implies, infusions are made by pouring water upon coarsely powdered vegetable substances and allowing the mixture to stand or *infuse* for a definite period, the solid particles being removed by straining. *The marc is not pressed.*

Boiling water is used whenever possible, as in the short time allowed for extraction it is a quicker and more powerful solvent of the active principles than cold water. In certain cases the use of hot water is undesirable—e.g., *Infusum Calumbæ* and *Infusum Quassia*. In the first instance hot water takes up so much starch as to render the infusion unpleasantly thick, while its keeping properties are even worse than at present. Infusion of quassia is perhaps sufficiently bitter when made with cold water, otherwise there is no apparent reason for a deviation from the general method.

It is not an infrequent practice to leave infusions in the vessels in which they have been prepared, in contact with the solid ingredients, for a much longer time than that specified by the Pharmacopœia, the liquor being drawn off as required. This practice, by which continued maceration is maintained, is very objectionable, the character of the product being completely altered. This is well exemplified by comparing freshly-made with over-drawn *tea*. The former contains most of the aromatic principles and caffeine, while the latter, in addition, is loaded with tannin and extractive matter.



FIG. 140.

The preparation of infusions is exceedingly simple, the water being poured upon the material in an earthenware jar, as fig. 140, infused for the stipulated time, and strained off. The ingredients being suspended in a perforated cup near the surface of the liquid, the water in immediate contact becomes charged with extractive and sinks to the bottom, fresh water taking its place. At the end of the operation, the cup with the marc can be lifted out, leaving the infusion ready for use.

Infusions of vegetable substances are very prone to decomposition, and, with the exception of cloves, roses, and cinchona, should be freshly made every morning or when required. The first two mentioned will keep good for some weeks, infusion of cinchona for some days. On the other hand, the infusions of digitalis, calumba, and senna begin to decompose in a few hours, especially if the weather is very warm. Various methods have been suggested from time to time for preserving infusions, but in no case should the addition of salicylic acid, boric acid, or formaldehyde be countenanced.

The following table gives the time and average extractive of the official infusions :

	Time of Infusion	Extractive (grammes per 100 c.c.)
Infusum Aurantii	15 minutes	1·10
„ Aurantii Co.	15 „	0·62
„ Buchu	15 „	0·45
„ Calumbæ	30 „	0·30
„ Caryophylli	15 „	0·40
„ Cascarillæ	15 „	0·36
„ Chiratæ	15 „	0·43
„ Cinchonæ Acidum . . .	60 „	0·79
„ Cuspariæ	15 „	1·12
„ Digitalis	15 „	0·24
„ Ergotæ	15 „	0·27
„ Gentianæ Co.	15 „	0·65
„ Krameriæ	15 „	0·90
„ Lupuli	15 „	1·10
„ Quassiæ	15 „	0·13
„ Rhei	15 „	1·30
„ Rosæ Acidum	15 „	0·85
„ Scoparii	15 „	0·85
„ Senegæ	30 „	0·63
„ Sennæ	15 „	2·50
„ Serpentariæ	15 „	0·50
„ Uvæ-Ursi	15 „	0·26

Concentrated infusions.—Although these latter are not mentioned in the Pharmacopœia under the above heading, an attempt has been made to include a certain number under the description of *Concentrated Solutions*. Instead, however, of being made of such a strength that one fluid part diluted with seven parts of water should represent as far as possible an original infusion, they are more concentrated, being in the proportion of one to nine. This degree of concentration does not apparently lend itself to general practice, as the preparations are in but little demand. The impracticability of concentrating an aqueous infusion of a vegetable substance so that, when diluted again with distilled water to the original bulk, *it shall actually represent every*

character of the fresh infusion is well known, but there are methods by which concentrated preparations can be produced which do represent the active principles and give a fair idea of the aroma and flavour.

Ten of these concentrated solutions are official, and all are made by the processes of maceration and percolation, 20-per-cent. alcohol being used as the solvent. As before mentioned, they are practically ten times the strength of the official infusions :

	Specific Gravity	Extractive (grammes per 100 c.c.)	Percentage of Alcohol by volume
Liquor Calumbæ Concentratus	0.990-0.998	3.6 - 4.3	19-20
" Chiratæ "	0.990-1.010	4.5 - 5.2	18-19
" Cuspariæ "	1.008-1.018	9.5 -10.2	18-19
" Krameriæ "	1.010-1.020	9.0 -10.0	18-19
" Quassiæ "	0.975-0.980	0.25- 0.3	18-19
" Rhei "	1.015-1.025	11.0 -12.7	18-19
" Sarsæ Co. "	1.025-1.040	12.0 -15.0	18-20
" Senegæ "	1.010-1.025	11.0 -12.0	19-22
" Sennæ "	1.030-1.070	12.0 -16.0	18-19
" Serpentariæ "	0.990-1.000	4.0 - 5.0	18-19

Decoctions

Decoctions (Latin *de*, and *coquo*, I cook) are aqueous preparations obtained by boiling drugs with water in order to extract principles which would not be so readily taken up by simple infusion. The process of decoction is not applicable to substances containing aromatic or volatile principles, but is confined to the exhaustion of such drugs as owe their properties to astringent extractive matter, etc.

The general method for the preparation of decoctions consists in boiling the sliced or coarsely bruised materials in a covered vessel with distilled water for a specified time, straining, and making the product up to measure with more water.

For making quantities of one to two pints earthenware pipkins (fig. 141) are to be preferred. Copper vessels, well tinned inside,

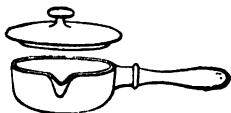


FIG. 141.

may, however, be used, while saucepans made of aluminium may also be obtained, and possess many advantages. Care should be taken only to select such as are turned or spun out of a single sheet of metal, as vessels in which solder has been used deteriorate very rapidly. Iron or tinned-iron vessels should never be used, on account of the discoloration occasioned in decoctions containing astringent matter.

Decoctions, like infusions, are very liable to decomposition, and should only be prepared as required. The remark under the heading of Infusions concerning the addition of preservative agents applies equally to decoctions.

CHAPTER XVII

LINIMENTS

Liniments (from the Latin *linio*, I smear) are external applications intended to be rubbed or painted over the affected parts of the body. The bases of the various liniments vary greatly, some being entirely spirituous, while others are oily or soapy.

Linimentum Aconiti and *Linimentum Belladonnæ* are really strong tinctures, camphor being added, partly for its rubefacient properties and partly to distinguish them from preparations for internal use.

Linimentum Aconiti.—Sp. gr. 0·860 to 0·875; *Extractive*, 5 to 5·2 per cent. ; *Percentage of Alcohol by volume*, 79 to 81.

Linimentum Belladonnæ.—Sp. gr. 0·885 to 0·895; *Extractive* varies greatly, but averages about 5 per cent. ; *Percentage of Alkaloid*, 0·375 gramme in 100 c.c. ; *Percentage of Alcohol by volume*, 69 to 71.

The following eleven liniments are merely mixtures :

Linimentum Ammoniæ.—A partial emulsion is formed owing to saponification of some of the oil by the caustic ammonia.

Linimentum Calcis.—This also contains a soap (insoluble) formed by the lime.

Linimentum Camphoræ.

Linimentum Camphoræ Ammoniatum.

Linimentum Chloroformi.

Linimentum Crotonis.

Linimentum Hydrargyri.

Linimentum Opii.

Linimentum Saponis.

Linimentum Sinapis.

Linimentum Terebinthinæ Aceticum.

The two remaining liniments are more interesting from a pharmaceutical point of view—

Linimentum Potassii Iodidi cum Sapone.—This consists of a gelatinous solution of curd soap containing potassium iodide. The shredding is most conveniently accomplished, by taking off thin

shavings from a bar of soap fixed against a projection on a board, with an ordinary joiner's plane. If properly managed the shavings will be thin enough to dissolve rapidly on warming with the water, but in any case the tare of the vessel should be noted, so that loss by evaporation may be made up. When solution is complete, the liquor is strained through muslin on to the powdered potassium iodide contained in a *perfectly clean* mortar. Trituration must be continued until nearly cold, when the oil of lemon is added. This last ingredient not only covers the odour of the soap, but produces a much whiter and more frothy liniment.

Unfortunately, the liniment loses its frothy characteristic on keeping, partly by evaporation of water and partly by loss of the air that is whipped in during manufacture, the product after a few weeks becoming granular. If soft soap is used, a translucent jelly is formed.

Linimentum Terebinthinæ.—The official formula, if exactly followed, produces a creamy-white emulsion which keeps well and can be dispensed in fairly narrow-mouthed bottles. Good results may be obtained in several ways, but all require some practice and considerable manipulative skill :

(a) The soap is dissolved in the water and made perfectly smooth, the solution of the camphor in the turpentine being added in very small quantities at a time. Each addition must be thoroughly incorporated before adding more. Much depends upon the start, as a liniment badly started cannot afterwards be set right by any amount of trituration.

(b) The camphor and soap are dissolved in the turpentine by the aid of gentle heat, and the water added (warm) all at once. If the admixture is made in a large wide-mouthed bottle and vigorously shaken until the contents have cooled, a very fair liniment results.

(c) *This is the quickest and the surest method.* It depends upon the use of oleic acid and alkali in molecular proportions to produce the prescribed amount of soap. The oleic acid and camphor are dissolved in the turpentine, to which is added the caustic potash dissolved in the distilled water, in a large wide-mouthed bottle. On shaking, a creamy non-separable liniment is produced in a few moments.

Proportions.—

Oil of Turpentine	85·0
Camphor	6·5
Oleic Acid	8·5

Linimentum Camphoræ.—Much trouble and annoyance has been caused by the adoption of improper means for dissolving the camphor in the oil. The camphor *must be in the form of 'flowers,'* as if used

in the form of 'blocks' or 'bell' there is great loss by volatilisation. A very convenient plan for making small batches is to heat the oil in a lever-lid tin to about 70° C., add the camphor, fit on the lid, and shake occasionally until cold.

Test.—Five grammes is heated for two hours in a shallow flat-bottomed dish to 120° C. and the loss determined. Olive oil under the same conditions gains in weight to the extent of 0.15 per cent.

Camphorated oil should contain from 21 to 22 per cent. of camphor.

CHAPTER XVIII

MEDICATED WATERS

The medicated waters of the Pharmacopœia consist of aqueous solutions of the volatile principles of vegetable substances, the solitary exception being *Aqua Chloroformi*.

	Percentage of Drug	
<i>Aqua Anethi</i> . . .	10	These are prepared by distilling the drug with water. The first runnings are generally reserved, being put back into the still when about half the volume has come over, to be redistilled with the remainder. By this means an even product is assured. It should be noted that these waters when freshly distilled are milky owing to the presence of suspended oil globules, but gradually become clear on standing.
„ <i>Anisi</i> . . .	10	
„ <i>Carui</i> . . .	10	
„ <i>Cinnamomi</i> . . .	10	
„ <i>Fœniculi</i> . . .	10	
„ <i>Pimentæ</i> . . .	5	

See note, page 52, on the distillation of essential oils.

Aqua Camphoræ.—The strength is intended to be about 0·1 per cent., with about 0·3 per cent. of alcohol. Water saturated with camphor contains as nearly as possible 0·1 per cent., and as the B.P. preparation is evidently intended to be of about this strength no particular advantage is derived from the use of alcohol.

Aqua Chloroformi is simply a solution of chloroform 0·25 per cent. in water.

Aqua Laurocerasi.—The distillate from the freshly bruised leaves of cherry laurel contains a varying amount of hydrocyanic acid and possesses an agreeable odour resembling oil of bitter almonds. These principles are not originally present in the leaves, but are produced by the hydrolysis of a glucoside resembling amygdalin (compare Oil of Bitter Almonds). To obtain the best result, therefore, the crushed leaves should be left in contact with the water for about an hour before commencing distillation.

Aqua Laurocerasi is a potent remedy, being in this respect unlike the other members of its class, which are practically harmless, and the doses of which are regulated to taste. It is standardised,

as described under *Acidum Hydrocyanicum Dilutum*, to contain 0.1 per cent. of hydrogen cyanide, and is therefore one-twentieth the strength of the first-named.

Aqua Menthæ Piperitæ. } These two waters are made by simply
Aqua Menthæ Viride. } distilling the respective essential oils with sufficient water to produce a distillate containing one part in 1000. The first runnings should be reserved and put back into the still when about one-half the volume has passed over, thus assuring a more uniform product.

Aqua Aurantiæ Floris. } The preparation of these odorous waters
Aqua Rosæ. } is carried out in a similar manner, al-
Aqua Sambuci. } though only the last two can be pre-
pared in this country. The fresh or salted flowers are placed in a steam-jacketed still, with excess of water, and distilled. The proportions approximate 5 lb. of flowers to each gallon of distillate.

In the preparation of lotions, etc., orange-flower water and rose-water are required to be diluted to one-third the strength immediately before use.

The foregoing methods for preparing medicated waters have been subjected to much criticism. It is well known that excellent products are obtainable by shaking the respective essential oils with distilled water—containing a little washed talc—in the proportion of half a minim per fluid ounce, and filtering; indeed, in the last edition of the *United States Pharmacopœia* this method has been made official, the only difference being that a greater proportion of oil is used than is now suggested.

CHAPTER XIX

PERCENTAGE SOLUTIONS, LIQUORS, ETC.

Solutions are homogeneous mixtures which cannot be separated into their constituent parts by mechanical means. The ability of substances to form such mixtures or solutions varies according to the state of aggregation of the substances.

Gases mingle with one another in all proportions to form homogeneous mixtures, except when they combine to form chemical compounds. A large number of liquids are known to dissolve in one another, but the number of pairs of liquids which mutually dissolve in all proportions is exceedingly small. The solution of solids in solids, although an established fact, need not here be considered.

Solutions of gases in liquids.—Every liquid possesses the property of mingling with every gas to form a homogeneous mixture or solution. According to Henry's Law, *the quantity of gas dissolved by a specified quantity of liquid is proportional to the pressure.* The greater the pressure, the larger the volume of gas dissolved. Thus, directly the pressure in a bottle of aerated water is released some of the dissolved gas is evolved. Gases are more soluble in cold liquids than in hot, and, as a rule, a gas can be expelled from a liquid simply by raising the temperature.

When a gas is brought into contact with a liquid at normal pressure, absorption begins at once and the surface layer of the liquid becomes saturated; the dissolved gas mixes with the lower layers by diffusion, and the surface layer again absorbs a fresh portion. This process goes on until the whole bulk of the liquid becomes saturated with the gas. The foregoing, however, takes place comparatively slowly, and in commercial operations it is found necessary to hasten solution by bubbling the gas through the liquid under pressure, or by agitating the liquid so as constantly to bring fresh portions into intimate contact with the gas, as in the manufacture of aerated waters.

Solution of liquids in liquids.—Unlike gases, liquids show considerable difference in their behaviour to one another, the differences depending upon the nature of the liquids. Liquids may be divided into three classes. *First*, those which behave to each other in the same manner as gases; that is, they mix with one another in all pro-

portions, as alcohol and water. *Secondly*, those which, although dissolving in one another, do not do so in all proportions, as ether and water. *Thirdly*, those which exert no mutual solvent action, as olive oil and water. Very few liquids, strictly speaking, belong to this class, as all liquids which show an appreciable vapour-pressure at the temperature of the experiment must be excluded—a solution of a vapour not being distinguishable from a solution of the liquid itself.

Solution of solids in liquids.—A solid body is said to dissolve in a liquid when the reaction results in a homogeneous mixture. When the quantity dissolved reaches a point such that no more can be taken into solution under the existing conditions, the liquid is said to be *saturated*. The point of saturation is dependent upon temperature. When this is changed, either some of the dissolved solid passes out of solution, or the liquid dissolves a further quantity. With few exceptions solid bodies dissolve more freely in hot than in cold liquids.

The solution of many bodies causes a considerable depression in the temperature, advantage of which is taken in the preparation of freezing mixtures. This is exemplified by dissolving crystallised calcium chloride or ammonium nitrate in water. On immersing a thermometer the mercury sinks at once owing to the absorption of heat. Liquids exercise a certain selective action in the solids they take up. Thus, water dissolves a number of salts which are practically insoluble in alcohol. On the other hand, alcohol dissolves a great many substances, such as organic bases, resins, camphor, etc., which are scarcely affected by water; and, without straining the idea too far, a relationship is observable in many cases between the chemical composition of the solvent and that of the solid it dissolves. Ether and benzene, both highly carbonaceous liquids, dissolve fats and other substances rich in carbon; phosphorus trichloride dissolves phosphorus; carbon disulphide is the best solvent for the common form of sulphur. The relation cannot, however, be said to be general, and at present we possess few clues to the laws regulating the solution of solids in liquids.

The rate of solution is directly proportional to the surface exposed to the action of the solvent. Solid bodies, therefore, should be reduced to small particles before adding to the liquid, when speedy solution is desired.

The ordinary method of determining the solubility of a substance in a given solvent is to place a convenient volume of the latter in a small flask, the powdered substance being added until a little remains undissolved. The mixture is then warmed gently until complete solution is effected, when it is set aside for twenty-four hours, shaking and stirring occasionally. The solution is next filtered through paper into a tared capsule and weighed. It is then evaporated until the weight remains constant. The weight of residue gives the amount

of solid in the solution taken, and from this the ratio of solubility is readily calculated.

If the solvent is of a very volatile nature, considerable difficulty is experienced in obtaining concordant results when the foregoing process is employed. Accurate results may, however, be obtained by the use of the *lysimeter*, an apparatus devised by Dr. C. Rice.

This (fig. 142) consists of a glass tube, A, 15 centimetres long and 1 centimetre in diameter, provided at one end with a stopper, C, the other end being cup-shaped, there being a contracted neck between the cup and the main tube. Into this cup a glass bell, E, is fitted, having a small perforation in its bottom (as shown in F). There is also a stopper, B, which is ground to fit into the cup, and which is inserted after the glass bell, E, has been removed. The several stoppers, etc., are all numbered.

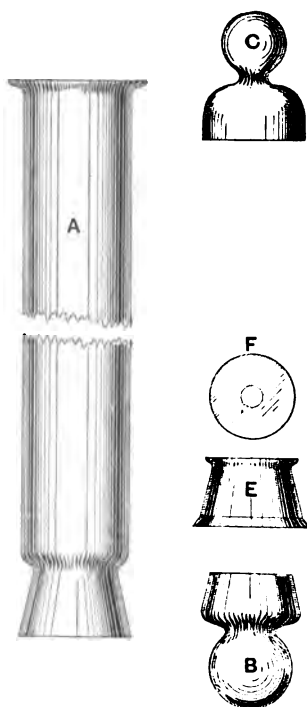


FIG. 142.—LYSIMETER.

The lysimeter is prepared for use by inserting the stopper C and introducing into the cup-shaped end the glass bell, E, containing a plug of absorbent cotton. A sufficient amount of liquid having been introduced into a beaker, heat is applied and the powdered substance added until, after the boiling has been kept up for some time, a small quantity remains undissolved. The prepared glass tube is now inserted in the solution. As long as the stopper C closes the upper end of the tube, no liquid will be able to filter in. When the tube has acquired the temperature of the boiling liquid, the stopper C is removed, liquid filtering through the cotton and rising in the tube until the levels correspond. In order to ensure uniformity of the liquid within and without the tube, it is best to allow the filtered portion to flow back through the cotton, and again filter in. The stopper C having been inserted, the tube is withdrawn, turned upside down, the filtering cup removed, and the stopper B inserted. The tube is now carefully cleaned and laid aside until cold. Its tare having been previously determined, the increase in weight represents the weight of the solution contained therein. On washing the contents into a tared dish and evaporating, the weight of the dissolved substance will be found.

Saturated solutions.—Saturated solutions are liquids impregnated to such an extent with a soluble substance that no more can be taken

up at the normal temperature. It has, however, been found that these solutions sometimes refuse to crystallise, even when cooled far below the normal temperature. Such liquids are said to be *super-saturated*. Thus, if water which has been saturated with sodium sulphate at 15° C. is gently warmed, and a few crystals of the same salt added, they will dissolve, and in many cases will not crystallise out again on regaining the normal temperature. If, however, a crystal of sodium sulphate is then dropped into the liquid, crystallisation commences at once, and proceeds so rapidly that in a short time the whole sets into a solid mass.¹

Percentage Solutions

Theoretically, a percentage solution should contain either a definite weight of active ingredient in 100 parts by weight, or a definite volume in 100 volumes; that is, both factors must be in the same terms.

The weight of substance and solvent necessary to produce a definite quantity of a percentage solution may be ascertained by applying the following rule: *Multiply the quantity of solution desired in grammes, ounces, or grains by the percentage, and divide the product by 100.* The quotient is the weight of substance required, and if this figure is deducted from the total weight of solution, the remainder is the weight of liquid to be used.

Example.—Required 1 gallon of aqueous mercuric chloride solution 1 in 1000.—A gallon of water weighs 70,000 grains, then $\frac{70,000 \times 0.1}{100} = 70$. Therefore 70 grains of mercuric chloride is to be dissolved in sufficient water to produce 1 gallon (= 10 lb., or 70,000 grains).

Practically, experience teaches that medical men rarely if ever intend *true* percentage solutions to be dispensed in fulfilment of their prescriptions, and for this reason: without making a calculation based upon the specific gravity of the solvent, it is impossible to say what will be the result to the patient when the solvent is other than distilled water. This is best explained by an example:

If a gallon of aqueous solution of mercuric chloride 1 in 1000 is made according to the above rule, it will contain 70 grains of active ingredient, but if 90-per-cent. alcohol (sp. gr. 0.834) is used instead of water it will only contain 58.38 grains, because a gallon of alcohol of this strength only weighs 58,380 grains ($70,000 \times 0.834 = 58,380$).

Now, it is extremely probable that if a medical man ordered a gallon of each of the solutions mentioned, he would expect them to

¹ A supersaturated solution of sodium sulphate can generally be made to crystallise by sending a puff of air through the liquid by means of ordinary bellows, the reason being that the atmosphere of rooms almost invariably contains minute crystals of that salt.

contain an identical weight of mercuric chloride. This being so, *it has become customary to regard percentage solutions as containing definite unit weights of active ingredient dissolved in the measure of 100 fluid units of water.* It is of no moment which units are selected. If the grain, then a 5-per-cent. solution will contain 5 grains dissolved in 100 fluid grain measures; if the gramme, then 5 grammes in 100 c.c.

It is evident from this that the specific gravity of the solvent will have no bearing on the weight of active ingredient contained in any given volume of solution, as the fluid unit is the same for all—viz., *the volume of a unit weight of water.* Thus, a gallon of a solution 1 in 1000 will contain 70 grains of ingredient, whether prepared with water sp. gr. 1.000, ether sp. gr. 0.720, or glycerin sp. gr. 1.260.

The great stumbling-block to the proper conception of percentage solutions has undoubtedly been the confusion of the minim with the fluid grain or grain measure. *A minim is not the equivalent of a fluid grain, but is only a fractional part.* A gallon of water weighs 70,000 grains and measures 70,000 fluid grains or 76,800 minims. In other words, a minim is practically equal to nine-tenths of a fluid grain (exactly, to 0.9114583 of a fluid grain).

The rule may therefore be re-stated as follows: *Multiply the volume of solution required, expressed in fluid grains, fluid ounces, or cubic centimetres, by the desired percentage, and divide by 100.* The quotient is the weight of substance to be taken, which must be dissolved in sufficient solvent to produce the required volume.

Examples.—(1) Required 4 fluid ounces of 5-per-cent. aqueous solution of cocaine hydrochloride.

$$4 \text{ fluid ounces} = 1750 \text{ fluid grain measures}; \text{ then } \frac{1750 \times 5}{100} = 87.5.$$

Therefore 87½ grains of the salt is to be dissolved in water and made up to 4 fluid ounces.

(2) Required 2 fluid ounces of 8-per-cent. solution of iodoform in ether sp. gr. 0.735.

$$2 \text{ fluid ounces} = 875 \text{ fluid grain measures}; \text{ then } \frac{875 \times 8}{100} = 68.$$

That is, 68 grains of iodoform must be dissolved in sufficient ether to produce 2 fluid ounces.¹

Formulæ for increasing or decreasing the strength of percentage liquids

I. Given a liquid of known weight and percentage: required to know the quantity of a liquid of the same kind, of higher or lower

¹ The author is aware that the foregoing is open to objection, but points out that the Pharmacopœia prepares percentage solutions on the same principle. He is of opinion that far weightier reasons can be urged for its general adoption than for its rejection in favour of *true* percentage solutions. In this country, at any rate, it is not usual to weigh liquids.

percentage, or of water, which will have to be added to produce a desired percentage.

Let a be the quantity of the given liquid ;

b its percentage of important constituents ;

c the percentage of the liquid to be mixed with a ;

d the desired percentage of the mixture ;

x the quantity of the liquid, of higher or lower percentage, or the quantity of water, to be added to a .

(1) Then $x = \frac{a(b-d)}{d-c}$ if the liquid to be added is of higher or

lower percentage ; or in words : to find x (the quantity of liquid to be added), multiply the difference between the percentage of the liquid a and the desired percentage of the mixture d by the quantity of the liquid a , and divide the product by the difference between the desired percentage and that of the liquid to be mixed with a .

Example.—Supposing we have 40 parts of a liquid of 50 per cent., and want to mix it with a liquid of 20 per cent. in order to get one of 30 per cent., how much of the liquid of 20 per cent. should be added ?

$$\begin{aligned} x \text{ (the quantity of the liquid of 20 per cent.)} &= \frac{40(50-30)}{30-20} \\ &= \frac{40 \times 20}{10} = 80 \end{aligned}$$

(2) If water is to be added, $x = \frac{a(b-d)}{d}$; or in words : to find x

(the quantity of water to be added), proceed as described under (1), but divide the product by the desired percentage only.

Example.—Supposing we have 40 parts of a liquid of 50 per cent., and want to mix it with water in order to get one of 30 per cent., how much water must be added ?

$$x \text{ (the quantity of water)} = \frac{40(50-30)}{30} = \frac{40 \times 20}{30} = \frac{800}{30} = 26\frac{2}{3}$$

II. Given two liquids of the same kind, one of higher and the other of lower percentage ; or one of any percentage, the other being water : required to know the quantity of the weaker liquid to be added to the stronger to produce a desired weight and percentage.

Let a be the desired weight or quantity of the mixed liquids ;

b the percentage of the stronger liquid ;

c the percentage of the weaker liquid ;

d the percentage of the mixture ;

x the weight of the weaker liquid or of water to be added to the stronger.

(1) $x = \frac{a(b-d)}{b-c}$, if a stronger liquid is to be mixed with a weaker

one; or in words: to find x (the quantity of the weaker liquid), multiply the difference between the percentage of the stronger liquid and the desired percentage of the mixture by the desired weight or quantity of the mixed liquids, and divide the product by the difference between the percentage of the stronger and that of the weaker liquid.

Example.—Supposing we have a liquid of 60 per cent., and another of 20 per cent., and require 40 parts of a liquid of 30 per cent., how much of the 20 per cent. liquid must be taken?

$$x \text{ (the quantity of the weaker liquid)} = \frac{40(60-30)}{60-20} = \frac{40 \times 30}{40} = 30$$

Then the quantity of the stronger liquid will be 10 parts to produce the required 40 parts.

(2) $x = \frac{a(b-d)}{b}$, if a stronger liquid is to be mixed with water;

or in words: to find x (the quantity of water to be added) proceed as described under II. (1), but divide the product by the percentage of the stronger liquid only.

Example.—Supposing we have a liquid of 60 per cent., and want 40 parts of a liquid of 30 per cent., how many parts of water must be taken?

$$x \text{ (the quantity of water)} = \frac{40(60-30)}{60} = \frac{40 \times 30}{60} = 20$$

That is, 20 parts of water must be mixed with 20 parts of the given liquid.

Calculations for diluting liquids of certain specific gravity to lower specific gravity

Example.—Suppose we have 20 fluid ounces of liquid sp. gr. 1.165 to be diluted to sp. gr. 1.11, what proportion of water must be added?

The liquid is 0.055 *above* the required density.

The diluent, water, is 0.11 *below* the required density.

Therefore proportionately 0.055 part of water must be mixed with 0.11 part of the original liquid, or 1 part with 2 parts;

then quantity of water to be added $\frac{0.055}{0.11} = \frac{1}{2}$, and $\frac{1}{2} \times 20 = 10$ fluid ounces

That is, 10 fluid ounces of water must be mixed with the 20 fluid ounces of the liquid to bring it to the sp. gr. 1.11.

Or, suppose 30-vol. hydrogen-peroxide solution is required to be made from 100-vol. and 20-vol.

100 vol. is 70 vol. *above* the required strength

20 „ is 10 „ *below* „ „ „

Therefore 70 fluid parts of 20-volume must be mixed with 10 fluid parts of the 100-volume.

*General Solubility Tables.*¹

The following table of the solubility of salts in water at normal temperature was compiled by Dr. Attfield :

Acetates.—All soluble.

Arsenates. }
Arsenites. } —Insoluble, except those of the alkali metals.

Bromides.—Soluble, except mercurous and silver bromides. The bromides of antimony and bismuth form oxysalts when poured into water.

Carbonates.—Insoluble, except those of the alkali metals.

Chlorides.—Soluble, except mercurous and silver chlorides. Lead chloride is only sparingly soluble in cold water. The chlorides of bismuth and antimony form oxysalts when poured into water.

Citrates.—Manganese, silver, strontium, and mercurous citrates are insoluble. Those of the alkali metals, lithium, iron, calcium, and magnesium are freely soluble ; the remainder only sparingly soluble.

Cyanides.—Insoluble, except the cyanides of the alkali metals and alkaline earths, and mercuric cyanides.

Hydroxides.—Insoluble, except the hydroxides of the alkali metals, and the hydroxides of calcium, strontium, and barium. The latter are only sparingly soluble.

Iodides.—Antimony, bismuth, and gold are insoluble. Lead, silver, mercuric and mercurous iodides are only sparingly soluble ; the remainder are all soluble.

Nitrates.—Soluble.

Oxalates.—Generally insoluble except those of the alkali metals.

Oxides.—Insoluble, except the oxides of the alkali metals ; barium, strontium, and calcium very slightly soluble.

Sulphates.—Soluble, except barium sulphate. The sulphates of calcium, strontium, antimony, lead, and mercury (*-ous*) are sparingly soluble.

Sulphites.—Soluble, except those of aluminium, antimony, and bismuth.

Tartrates.—Soluble, except the tartrates of antimony, barium, and bismuth.

Solutions (Liquores)

The pharmacopœial Solutions, or Liquors, may be divided into two classes :

(1) *Concentrated vegetable solutions*.—These have been already dealt with under 'Infusions.'

¹ For complete table of solubilities see page 390.

(2) *Solutions of definite chemical substances.*—Of these the following five are simple solutions of an alkaloidal salt :

<i>Liquor Atropinæ Sulphatis</i>	} <i>Strength</i>
<i>Liquor Morphinæ Acetatis</i>	
<i>Liquor Morphinæ Hydrochloridi</i>	
<i>Liquor Morphinæ Tartratis</i>	
<i>Liquor Strychninæ Hydrochloridi</i>	

1 part by weight
in 100 fluid parts

Liquor Acidi Chromici.—Contains one part by weight of chromic anhydride in three parts of water.

Liquor Ammoniac Fortis.—May be prepared by heating ammonium chloride with calcium hydroxide, and dissolving the purified gas, NH_3 , in distilled water. The solution contains 32.5 per cent. of ammonia, NH_3 . The specific gravity is given as 0.89, but on comparing this with the ammonia tables it will be seen that such a gravity corresponds to 31.5 per cent. of NH_3 .

Ammonia gas is exceedingly soluble in water, one volume of the latter at normal temperature and pressure dissolving over 1100 volumes of NH_3 .

Liquor Ammoniac is made by diluting one volume of the above with two volumes of distilled water.

Liquor Ammoniac Acetatis.—Although the official directions appear so simple, it is by no means easy to prepare a *neutral* solution, as litmus-paper is unreliable as an indicator, while if the solution is heated to expel carbon dioxide, the ammonium acetate suffers dissociation and an acid reaction is obtained. The best way is to powder the ammonium carbonate and determine its neutralising power on one gramme with $\frac{N}{1} \text{H}_2\text{SO}_4$, using methyl orange as indicator. The acetic acid is next titrated with $\frac{N}{1} \text{NaOH}$ (indicator, phenolphthalein). In titrating the ammonium carbonate it is well to add a decided excess of normal acid at once, and to titrate back with $\frac{N}{1} \text{NaOH}$. Reference to the volumetric tables at the end of this volume shows that

$$1 \text{ c.c. } \frac{N}{1} \text{H}_2\text{SO}_4 = 0.052003 \text{ Ammon. Carb. B.P.}$$

$$1 \text{ c.c. } \frac{N}{1} \text{NaOH} = 0.05958 \text{ Hydrogen Acetate} = 0.1805 \text{ Acid. Acetic. B.P. (containing 33 per cent. Hydrogen Acetate)}$$

$$\therefore 0.052003 \text{ gramme Ammon. Carb. B.P.} = 0.1805 \text{ gramme Acid. Acetic. B.P.}$$

$$\therefore 1 \text{ part by weight} = 3.47 \text{ parts by weight Acid. Acetic. B.P.}$$

If the ingredients are strictly B.P. it suffices to mix the acid (3·47 parts by weight) with distilled water to produce about nineteen ounces, and add one part by weight of powdered ammonium carbonate in small portions at a time, thus avoiding too violent an effervescence. As soon as solution is effected the mixture is made up to one pint and bottled to prevent loss of carbon dioxide, as the more highly the preparation is carbonated, the better it keeps.

It has been found convenient to make a solution eight times the strength of the B.P. and to dilute it with aerated distilled water (from a syphon) as required. Both *Liquor Ammoniae Acetatis* and *Liquor Ammoniae Citratis* attack glass very readily, therefore they should be stored in vessels free from lead glaze.

Liquor Ammonæ Citratis.—This is prepared in a similar manner to the foregoing, the neutralising power of the ammonium carbonate and citric acid being previously determined by titration.

1 c.c. $\frac{N}{1}$ $H_2SO_4 = 0.052003$ gramme Ammon. Carb. B.P.

1 c.c. $\frac{N}{1}$ NaOH = 0.06950 gramme Crystallised Citric Acid

$\therefore 0.052003 \text{ gramme Ammon. Carb.} = 0.0695 \text{ Citric Acid}$

\therefore 1 part by weight „ „ = 1.33 part „ „

NOTE.—In preparing large quantities of the two foregoing solutions it is customary, after ascertaining the neutralising power by titration, to mix the ingredients in the correct proportions, afterwards diluting to the required specific gravity with water.

Liquor Arsenicalis (Fowler's solution).—A solution containing one part of arsenious anhydride (As_2O_3) in 100 fluid parts. Potassium carbonate is added to ensure solution of the arsenious anhydride, but it is doubtful if any potassium arsenite is formed.

Twenty-five c.c. previously *neutralised* with hydrochloric acid and boiled with 1 gramme sodium bicarbonate for five minutes, cooled, and diluted with water to which a few drops of starch mucilage has been added, should discharge the colour of 50.8 c.c. $\frac{N}{10}$ iodine solution.

Were the potassium carbonate not neutralised in the first instance it would react with the iodine, whereas the bicarbonate, which is used to neutralise the hydriodic and arsenic acids formed, is without action.

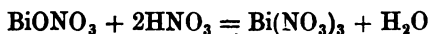
Old samples of Liquor Arsenicalis generally contain arsenic acid, especially if the solution has been kept in partly filled bottles. The flocculent precipitate occasionally seen is not as a rule caused by a fungus, as has been stated, but results from the action of the alkaline carbonate on the glass. The preparation would keep better and be much safer if *neutralised* with hydrochloric acid. There would be

then less danger in prescribing it with preparations of the poisonous alkaloids. See Incompatibles (page 309).

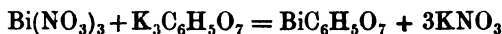
Liquor Arsenici Hydrochloricus.—This solution also contains one part of arsenious anhydride in 100 fluid parts. Arsenious chloride, which may be obtained by distilling arsenious anhydride with sodium chloride and strong sulphuric acid, is decomposed by water into its constituents, so that it is probable the official preparation only represents a solution of arsenious anhydride in hydrochloric acid, although it appears in some way to increase the solubility of the anhydride.

Liquor Arsenii et Hydrargyri Iodidi (Donovan's solution).—The solution contains the iodides dissolved in about molecular proportions. Care should be taken to see that the arsenic iodide is in good condition, as if any free iodine is present, dark-coloured solutions result. When freshly made, the solution has a pale-yellow colour, which on exposure to direct sunlight gradually disappears, hydriodic and arsenious acids being formed. The preparation was originally introduced by Dr. Donovan, of Dublin, who recommended it to be made by rubbing arsenious oxide, mercury, and iodine with a small quantity of alcohol, which was supposed to aid combination, the resulting dry mass being afterwards extracted with water and boiled.

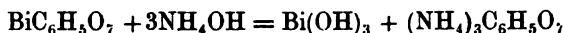
Liquor Bismuthi et Ammonii Citratis.—Bismuth oxynitrate is dissolved in nitric acid, bismuth nitrate being formed :



This is diluted with water until faintly opalescent, indicating that a small amount of oxynitrate has been re-formed. The potassium citrate and carbonate are then added, *dissolved in the least possible quantity of water*, producing a voluminous precipitate of bismuthous citrate. The carbonate simply neutralises the acidity, the reaction that occurs being



More water is then added, and the mixture boiled for some minutes until the precipitate becomes granular, in which condition it is, as rapidly as possible, washed free from nitrate, drained, and dissolved in the ammonia. The resulting solution probably contains a soluble complex salt of ammonium-bismuth-citrate. *Compare the action of ammonium citrate in the preparation of Ferri et Ammonii Citras.*



If the preparation has been insufficiently boiled, the washing is very tedious and the salt becomes much less soluble in ammonia.

A slight opalescence is frequently observed in the finished product, but it generally disappears on keeping. The solution should be distinctly ammoniacal, and some makers add a slight excess of ammonium citrate to ensure the bismuth hydroxide being completely held up.

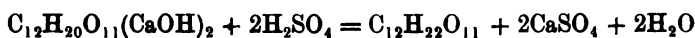
Ten c.c. of the solution diluted with about 40 c.c. of water gives with hydrogen sulphide a precipitate of bismuth sulphide, which, after washing and drying, should weigh at least 0.55 gramme, equivalent to about 0.5 gramme Bi_2O_3 per 100 c.c.

Liquor Calcis.—This is prepared by saturating water with washed slaked lime—calcium hydroxide. As lime-water rapidly loses strength when exposed to the air, owing to deposition of the lime as carbonate, it should be recently prepared. The most convenient method is to keep the water with excess of freshly slaked lime in a well-corked stone jar, shaking thoroughly *each time* and filtering off only sufficient for two or three days' consumption.

Twenty-four c.c. should require for neutralisation 10 c.c. $\frac{\text{N}}{10} \text{H}_2\text{SO}_4$, corresponding to about 0.1 per cent. (accurately 0.115 per cent.) of calcium oxide (indicator, litmus).

Liquor Calcis Saccharatus.—When cane-sugar solution is added to certain oxides, soluble salts known as saccharosates are formed. Thus, saccharated solution of lime contains calcium saccharosate, $\text{C}_{12}\text{H}_{20}\text{O}_{11}(\text{CaOH})_2$. These salts are not very stable, being readily decomposed by excess of water or carbonic anhydride. If the solution is prepared from lime free from iron, obtained by burning marble, it can be preserved without appreciable change of colour for a long time, but if prepared from commercial lime it soon darkens.

Ten grammes should require for neutralisation 6.3 c.c. $\frac{\text{N}}{1} \text{H}_2\text{SO}_4$, corresponding to 1.75 per cent. of calcium oxide (indicator, litmus).



$$\begin{array}{cc} 4) \ 111.18 & 4) \ 194.68 \\ \hline 27.79 & 48.67 \end{array}$$

That is, 1000 c.c. $\frac{\text{N}}{1} \text{H}_2\text{SO}_4 = 27.79$ grammes CaO

$$\therefore 1 \text{ c.c. } \quad \quad = 0.02779 \text{ gramme } \text{CaO}$$

$$\therefore 6.3 \text{ c.c. } \quad \quad = 0.175 \text{ gramme } \text{CaO}$$

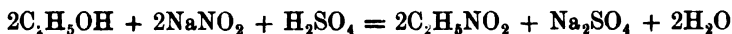
Liquor Caoutchouc.—A solution of rubber in a mixture of benzol and carbon disulphide.

Liquor Epispasticus (blistering liquid).—A solution of the active principle of cantharides (cantharidin) in acetic ether. Prepared by

percolation. When pressing the marc, etc., care must be taken not to get any of the liquid on the skin, or a blister will result.

Liquor Ethyl Nitritis.—This may be prepared by the following process : Dissolve 635 grammes of sodium nitrite in 1 litre of ice-cold distilled water, and put the solution into a glass or earthenware retort connected with an efficient condenser ; then add 550 c.c. of 90-per-cent. alcohol, and connect with a receiver kept *cold* in a mixture of pounded ice and salt. By means of a funnel passing through the tubulure and dipping beneath the surface of the liquid, gradually introduce a *cold* mixture of 520 grammes of sulphuric acid and 1 litre of water. Distillation commences when about half the acid has been added, and continues for some time. At first it may be necessary to cool the retort by immersing in a mixture of ice and salt, but as distillation proceeds the temperature may be allowed to rise so as to obtain the whole of the ethyl nitrite. Wash the distillate in a separator, first with 100 c.c. of *ice-cold* water to remove alcohol, and then with 100 c.c. of a 10-per-cent. solution of sodium carbonate to remove acidity. Finally shake the ethyl nitrite with 30 grammes of anhydrous potassium carbonate to remove the last traces of water. The purified ethyl nitrite may then be filtered into a definite weight of a mixture of five parts of glycerin and ninety-five parts of absolute alcohol, finally diluting if necessary with more of the same mixture, so that the solution will contain exactly 3 per cent. by weight.

The reaction that takes place is expressed by the following equation :

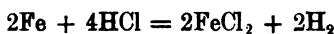


This solution does not contain any aldehyde, and, owing to the almost complete absence of water, is not readily hydrolysed ; consequently it keeps very much better than the analogous spirit of nitrous ether. When tested in a nitrometer as described under *Spiritus Ætheris Nitrosi*, one volume should yield at least 7·6 volumes of nitric-oxide gas when freshly made, and even old samples should yield at least 6·4 volumes.

Liquor Ferri Acetatis.—Ferric hydrate is first prepared by pouring solution of ferric sulphate into excess of dilute solution of ammonia. If the order of mixing is reversed, some oxysulphate is produced, owing to the ferric hydrate first precipitated combining with undecomposed ferric salt. The ferric hydrate is collected on a calico filter, washed with water until free from sulphate, pressed, dissolved in glacial acetic acid, and diluted. Unless this solution is very carefully prepared it deposits an oxysalt on keeping. To avoid this, the various operations should be conducted at as low a temperature and with as little exposure as possible.

Liquor Ferri Perchloridi Fortis.—Iron is added to hydrochloric acid until at the last a little iron remains undissolved. The filtered solution is then mixed with excess of hydrochloric acid, and poured in a thin stream into nitric acid, heat being applied to promote reaction; the solution is then evaporated until a precipitate begins to form. A little hydrochloric acid is added, and the whole diluted to the required volume with water.

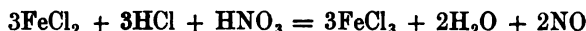
In the first part of the operation ferrous chloride is prepared :



On mixing this solution of ferrous chloride with more hydrochloric acid and pouring into nitric acid, the reactions that take place may be explained as follows :

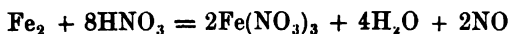
1. $2\text{HNO}_3 = \text{H}_2\text{O} + 2\text{NO} + 3\text{O}$
2. $\text{O} + 2\text{HCl} = \text{H}_2\text{O} + 2\text{Cl}$
3. $2\text{Cl} + 2\text{FeCl}_2 = 2\text{FeCl}_3$

Or in one equation :



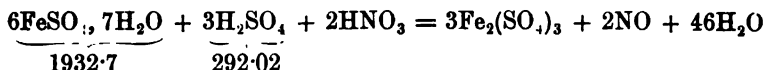
Liquor Ferri Perchloridi is made by simply diluting one volume of the above with three volumes of distilled water.

Liquor Ferri Pernitricis.—The action of nitric acid upon metals is of a complicated nature, the products of decomposition depending upon the strength of the acid, the temperature, and the presence of impurities. Generally speaking, nitric acid acts upon iron, forming ferric nitrate, nitric oxide, and water, thus :



If the action becomes too violent, water is added to prevent volatilisation of the acid. As the solution becomes cooler, and ferric salt accumulates, nitric oxide and even nitrogen itself are given off, while in certain cases ammonium nitrate is formed.

Liquor Ferri Persulphatis.—In the preparation of this liquor, crystallised ferrous sulphate is oxidised by means of nitric acid in the presence of an excess of free sulphuric acid. The reaction is analogous to that described under *Liq. Ferri Perchloridi Fortis*. Thus :



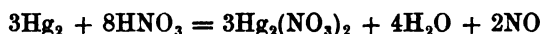
According to the above equation, 1932.7 grammes of crystallised ferrous sulphate requires 292.02 grammes of hydrogen sulphate, equivalent to 295.9 grammes of 98-per-cent. acid, or 160.5 c.c. (specific gravity being reckoned as 1.843). Therefore 400 grammes (the quantity

in the Pharmacopœia) would only require 33·2 c.c. of 98-per-cent. acid.

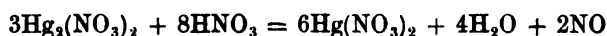
When ferrous-sulphate solution is poured into nitric acid a dark-coloured mixture at first results, due to the formation of an unstable compound of ferrous sulphate and nitric oxide, $2\text{FeSO}_4\cdot\text{NO}$. This compound is readily decomposed by heat, nitric oxide being evolved.

Liquor Hamamelidis.—A solution of the volatile constituents of fresh witch hazel leaves in dilute alcohol. Made by distillation in North America and imported into this country. The specific gravity varies from 0·980 to 0·985, and the alcohol from 16 to 18 per cent. by volume.

Liquor Hydrargyri Nitratis Acidus.—When mercury is dissolved in nitric acid in the cold, mercurous nitrate, $\text{Hg}_2(\text{NO}_3)_2$, is formed, thus :

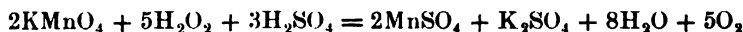


On heating this solution, which contains excess of nitric acid, mercuric nitrate is formed.



Liquor Hydrargyri Perchloridi.—A solution of mercuric chloride one part in distilled water 875 fluid parts, equivalent to half a grain per fluid ounce.

Liquor Hydrogenii Peroxidi.—Hydrated barium peroxide is made into a thin cream with water, and gradually added to cold, very dilute phosphoric acid, until the latter is almost neutralised. The slight excess of acid is nearly (but not quite) got rid of by adding barium hydroxide solution. One c.c. when tested in a nitrometer charged with brine, with a mixture of 1 c.c. of sulphuric acid, 2 c.c. of 5-per-cent. potassium permanganate solution, and 7 c.c. of distilled water, should yield at N.T.P. not less than 18 and not more than 22 c.c. of oxygen. The reaction is as follows :



It will be seen that two molecules of potassium permanganate yield five atoms of oxygen, the remaining five coming from the hydrogen peroxide ; thus of the 18 to 22 c.c. yielded in the test, only half belongs to the latter compound. The solution is commonly spoken of as '10-volume peroxide.'

Liquor Iodi Fortis.—A solution of iodine and potassium iodide in alcohol. It corresponds to Linimentum Iodi B.P. 1885. Specific gravity varies from 1·010 to 1·025 ; alcohol from 76 to 77 per cent. It contains 11·5 grammes of iodine per 100 c.c.

Liquor Magnesii Carbonatis.—Magnesium exhibits a great tendency to form basic compounds when a soluble salt is precipitated by an alkaline carbonate. Thus :



If, however, the basic carbonate is suspended in water, and the liquid saturated with carbon dioxide under pressure, it dissolves, forming the bicarbonate, $\text{MgH}_2(\text{CO}_3)_2$, just as calcium carbonate is dissolved in spring waters, communicating what is known as *temporary hardness*. Crystals of normal carbonate, MgCO_3 , may however, be obtained by allowing a solution of the bicarbonate to evaporate at a low temperature. In order to preserve the solution in a fit state for dispensing, it should be kept in ordinary aerated-water syphons. Twenty c.c., evaporated to dryness and calcined, should yield from 0.16 to 0.19 gramme of hydrated magnesium carbonate.

Liquor Pancreatis.—A preparation containing the digestive principles of the fresh pancreas of the pig. In the slaughterhouse two distinct organs are spoken of as sweetbread—the *thymus*, or *throat-bread*, which forms an article of food, and the *pancreas*, or *body sweetbread*, which lies just below the diaphragm. The latter is the organ used in preparing *Liquor Pancreatis*.

The sweetbreads are freed from fat and membrane, washed, minced finely, triturated with very coarse sand, and macerated in 20-per-cent. alcohol for seven days, shaking frequently. The mixture is then squeezed, mixed with fine silica, and allowed to stand until bright, when the clear liquor is drawn off.

In addition to a ferment which emulsifies fats, the pancreas contains at least two others—one, *amylolopsin*, capable of converting starch into sugar; the other, commonly referred to as *trypsin*, which digests proteids. Unlike pepsin, which acts in an acid solution, the digestive principles of the pancreas are only active when the solution is alkaline.

Liquor Pancreatis appears to lose its digestive properties somewhat quickly, but this deterioration may be retarded by adding from 5 to 10 per cent. of glycerin. From the nature of the ferments present it is evident that the solution may be standardised by its power of converting starch or of converting proteids into tryptones (analogous to peptones). The latter is the process employed in the *Pharmacopœia*.

If 2 c.c. of the solution, with 0.2 gramme of sodium bicarbonate and 20 c.c. of water, is added to 80 c.c. of fresh milk, and the mixture kept at 45° C. for an hour, coagulation should no longer take place on the addition of nitric acid, indicating complete digestion of the proteids.

Liquor Picis Carbonis.—Commercial coal-tar is heated in a shallow vessel for an hour at a temperature of about 50° C. to drive off ammonia, water, etc. In the pharmacopœial process a tincture of quillaia is first prepared, and the coal-tar digested in this for two days at a temperature of 50° C., stirring occasionally.

One hundred c.c. yields about 2·5 grammes of extractive; sp. gr. 0·855 to 0·865. When poured into water, the saponin present in the tincture prevents the phenol, cresols, naphthalin, etc., from separating, a milky emulsion being formed which persists for some time.

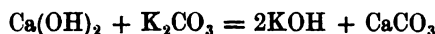
Liquor Plumbi Subacetatis Fortis (Goulard's extract).—This is prepared by boiling together approximate molecular weights of lead acetate and lead oxide; the resulting solution contains an oxyacetate having the composition $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2, \text{Pb}(\text{OH})_2$, with probably a little triplumbic acetate, $2\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2, \text{Pb}(\text{OH})_2$, a more basic and less soluble acetate being removed by filtration. The composition of this latter is probably $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2, 5\text{Pb}(\text{OH})_2$.

To facilitate combination, the lead oxide should be sifted into the water containing the lead acetate, and the mixture kept constantly stirred while boiling. If the clear solution is diluted with recently boiled distilled water no turbidity occurs, but on exposing to the atmosphere for a short time, carbonic anhydride is absorbed and a basic carbonate precipitated:



Instead of boiling the ingredients together as directed, an equally good result is obtained by allowing them to remain in contact at the ordinary temperature for two or three days. The specific gravity of the clear solution should be 1·275.

Liquor Potassæ.—This solution may be prepared by dissolving potassium hydroxide in water, or by adding excess of slaked lime, which has been deprived of soluble impurities by washing, to a weak boiling solution of potassium carbonate:



Sp. gr. 1·058. Nine c.c. should require for neutralisation 10 c.c. of $\frac{\text{N}}{\text{I}} \text{H}_2\text{SO}_4$, corresponding to 5·85 per cent. of KOH.

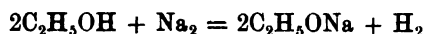
Liquor Sodæ Chlorinatæ.—Prepared by double decomposition. Bleaching powder may be expressed by the formula $2\text{Ca}(\text{OCl})\text{Cl} \cdot \text{Ca}(\text{OH})_2$; on treatment with water and adding solution of sodium carbonate the following reactions take place. *Ca(OCl)Cl is the active part of the molecule:*

1. $2\text{Ca}(\text{OCl})\text{Cl} = \text{CaCl}_2 + \text{Ca}(\text{OCl})_2$
2. $\text{Ca}(\text{OCl})_2 + \text{Na}_2\text{CO}_3 = \text{CaCO}_3 + 2\text{NaOCl}$

Sp. gr. 1.054. 3.5 grammes, mixed with 100 c.c. water containing 1 gramme of potassium iodide and acidulated with 6 c.c. of hydrochloric acid, yields a reddish solution which requires for the discharge of its colour at least 25 c.c. of $\frac{N}{10}$ $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$, corresponding to about $2\frac{1}{2}$ per cent. of available chlorine (indicator, starch mucilage).

Liquor Sodii Arsenatis.—An aqueous solution containing the equivalent of 1 gramme of the anhydrous salt, Na_2HAsO_4 , in 100 c.c.

Liquor Sodii Ethylatis.—Sodium decomposes ethylic alcohol, forming sodium ethylate or ethoxide, and liberating hydrogen :



This salt is soluble, and fairly stable, in absolute alcohol, but in presence of water it splits up into alcohol and sodium hydroxide.

The sodium must be clean and bright, or a dark-coloured solution will be the result. Each piece, as it is removed from the hydrocarbon under which it has been stored, should be placed on a slab, the tarnished surfaces cut off, and the remainder dried, weighed rapidly, and added to the alcohol. If the reaction becomes too violent, it must be modified by placing the flask in cold water. The solution darkens on keeping.

Liquor Thyroidei.—Prepared from fresh thyroid glands of the sheep. The gland consists of two dark lobes, which lie one on each side of the trachea and lower part of the larynx, connected by a band.

Immediately after the animal is killed the glands are removed, cut across, and any that appear unhealthy are rejected. The sound glands, having been counted, are sliced and bruised, and to each gland (consisting of two lobes) are added glycerin 2 c.c. and half-per-cent. solution of phenol in distilled water 2 c.c. The mixture is then transferred to a flask plugged with cotton wool, and allowed to stand for twenty-four hours in a cool place, when it is strained through calico and pressed, the expressed liquor being finally made up to 6 c.c. with half-per-cent. phenol solution.

The solution should be a pinkish turbid liquid which under ordinary conditions will keep good for about seven to fourteen days, depending on the temperature and method of storing. This result, however, can only be brought about by scrupulous cleanliness, the hands being cleaned by well washing with plenty of soap and hot water, and all utensils being sterilised before commencing.

Liquor Trinitrini.—This is a solution of glyceryl trinitrate (nitroglycerin or glonoin) in alcohol. When glycerin is allowed to fall drop by drop into a perfectly cold mixture of concentrated

nitric and sulphuric acids and the solution poured into cold water, nitroglycerin is precipitated as a heavy oil; this, when well washed and dried, is dissolved in 90-per-cent. alcohol. *On account of the highly explosive nature of nitroglycerin, its preparation should only be attempted by experts.*

Liquor Zinci Chloridi.—If pure metallic zinc were obtainable on a commercial scale, solution of zinc chloride could be prepared by dissolving the metal in hydrochloric acid. As, however, zinc is frequently contaminated with both lead and iron, purification is necessary. First, the metal is dissolved in hydrochloric acid and the solution cooled; if either of the above-mentioned impurities is present, chlorine in excess is bubbled through; this oxidises the iron to the ferric state, and, on the addition of zinc carbonate, ferric and lead carbonates are precipitated and filtered out.

CHAPTER XX

SYRUPS

The specific gravity of cane sugar is about 1.58. A saturated solution at 15.5° C. contains 67 per cent. of sugar and has a specific gravity of 1.346. Sugar is but slightly soluble in alcohol, and any considerable addition of spirit to a syrup causes precipitation of sugar.

Solubility of Cane Sugar in Alcohol (after Schufeldt)

Percentage of Alcohol by volume	Percentage of Sugar in solution	Grammes of Sugar soluble in 100 c.c.
6	64.25	179.7
12	62.20	164.5
18	60.40	152.5
24	58.55	141.2
30	56.20	128.3
36	54.05	117.8
42	51.25	105.3

It may here be mentioned that if by the aid of heat more sugar is taken into solution than suffices to saturate, crystallisation of the excess will take place, and crystals will keep on forming until the syrup becomes weaker than it would have been if the correct amount had been dissolved in the first instance.

Syrupus.—Simple syrup is prepared by dissolving two and a half pounds of sugar in one pint of water. Eight ounces of sugar and four ounces of water weigh twelve ounces and measure nine fluid ounces; a pound by weight measures twelve fluid ounces.

Percentage of Cane Sugar in Aqueous Syrup of known Specific Gravity, at 15° C.

P.c. of Sugar	Specific Gravity	P.c. of Sugar	Specific Gravity	P.c. of Sugar	Specific Gravity	P.c. of Sugar	Specific Gravity	P.c. of Sugar	Specific Gravity	P.c. of Sugar	Specific Gravity
10	1.0401	26	1.1107	36	1.1541	44	1.2003	53	1.2495	62	1.3017
16	1.0613	27	1.1154	36	1.1591	45	1.2056	54	1.2551	63	1.3077
19	1.0788	28	1.1201	37	1.1641	46	1.2110	55	1.2608	64	1.3138
20	1.0832	29	1.1248	38	1.1692	47	1.2163	56	1.2665	65	1.3198
21	1.0877	30	1.1296	39	1.1743	48	1.2218	57	1.2723	66	1.3260
22	1.0923	31	1.1344	40	1.1794	49	1.2272	58	1.2781	67	1.3322
23	1.0968	32	1.1393	41	1.1846	50	1.2327	59	1.2840	68	1.3384
24	1.1014	33	1.1442	42	1.1898	51	1.2383	60	1.2898	69	1.3446
25	1.1060	34	1.1491	43	1.1950	52	1.2439	61	1.2958	70	1.3509

Cane sugar only should be used in the manufacture of pharmaceutical preparations. Good sugar appears in pure white crystals

which dissolve in water to a colourless syrup. Inferior sugar has a yellowish tinge, which the makers seek to neutralise by the addition of ultramarine. On solution in water the latter deposits, but the chief objection to its presence is the readiness with which it liberates hydrogen sulphide on addition of an acid.

On the small scale simple syrup is preferably made in glass vessels *in the cold*. At normal temperatures quantities up to a gallon or so are easily prepared in twenty-four hours from granular sugar. If heated, great care should be taken to remove any alkali with which vessels may have been cleaned, as the least trace of either potash or soda imparts a brown tint to syrup on boiling. A brown tint may also be imparted by overheating, as at a temperature of 180° to 200° C. sugar loses water and is converted into caramel. Sp. gr. 1·330.

Syrupus Aromaticus.—Prepared by simple admixture. Kieselguhr should be used to assist filtration, as powdered talc makes the process abnormally slow. Sp. gr. 1·15 to 1·156.

Syrupus Aurantii.
Syrupus Aurantii Floris. } —Prepared by admixture.

Syrupus Calcii Lactophosphatis.—Calcium lactate is first formed by dissolving calcium carbonate in lactic acid, the phosphoric acid being afterwards added to the solution. A precipitate forms at first, but re-dissolves on stirring. The orange-flower water having been added, the sugar is dissolved without the aid of heat. Sp. gr. 1·32.

Syrupus Cascaræ Aromaticus.—Prepared by admixture. Sp. gr. 1·11 to 1·12.

Syrupus Chloral.—Prepared by admixture. Each fluid drachm contains ten grains of chloral hydrate. Sp. gr. 1·32.

Syrupus Codeinæ.—Prepared by admixture. Each fluid drachm contains a quarter grain of codeine phosphate. Sp. gr. 1·321.

Syrupus Ferri Iodidi.—By the pharmacopœial process a strong syrup is first prepared, and solution of ferrous iodide, obtained by digesting iodine with iron wire and water, filtered into it.

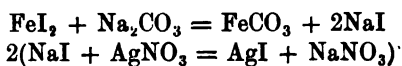
Syrup by the above process is excellent when first made, but does not keep very well, especially in partially filled bottles, a deposit of ferric oxyiodide being formed. The following *practically* answers the official requirements, and will, moreover, keep for a long time without change.

Iron Wire	1 ounce
Iodine	1452 grains
Glucose	2 ounces
Distilled Water	4 fluid ounces
Simple Syrup to make	2 pints

Place the iodine and iron wire in a flask with the water, and when combination appears to be complete, warm until the brown colour disappears; add the glucose; mix, and filter while still hot through a white filter-paper into a portion of the syrup, finally washing the filter with a little hot syrup. (The strong solution of ferrous iodide sinks to the bottom of the syrup and is well protected from the atmosphere.) When all has run through, remove the funnel, allow to cool, and make up to volume with simple syrup. *It is important not to wash the filter with water.* Sp. gr. 1.387.

When the iodine, iron, and water are first mixed the reaction proceeds but slowly, owing to the comparative insolubility of iodine in water. Afterwards the reaction may become very energetic—violet vapours being evolved—when the flask will require cooling. This is due to the iodine dissolving in the ferrous iodide as fast as it is formed, larger quantities being brought into contact with the iron.

Test.—Dissolve 1 gramme of dried sodium carbonate in 10 c.c. of distilled water in a flask, of which the capacity to a mark on the neck is 100 c.c.; weigh into the flask 13·87 grammes (= 10 c.c.) of the syrup, and agitate the mixture occasionally until the precipitation of the iron as ferrous carbonate is complete, then add more water to make the whole measure 100 c.c.; mix and filter. Twenty-five c.c. of the filtrate (= 2·5 c.c. syrup), exactly neutralised with dilute nitric acid, should require not less than 16 and not more than 16·5 c.c. of $\frac{N}{10}$ AgNO₃ for complete precipitation of the iodine, corresponding to 10 grammes of ferrous iodide in 100 c.c. Indicator, neutral potassium chromate.



Therefore $\text{FeI}_2 = 2\text{AgNO}_3$

$$\begin{array}{r} \overbrace{2)307\cdot4} \\ 10)\overline{153\cdot7} \\ \underline{15\cdot37} \end{array} \qquad \begin{array}{r} \overbrace{2)337\cdot38} \\ 10)\overline{168\cdot69} \\ \underline{16\cdot869} \end{array}$$

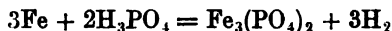
That is, 1000 c.c. $\frac{N}{10}$ $\text{AgNO}_3 = 15.37$ grammes ferrous iodide

1 c.c. „ = 0.01537 „ „

Therefore 1 gramme ferrous iodide = 65 c.c. $\frac{N}{10}$ AgNO₃ (1000 ÷ 15.37 = 65.06).

But 100 c.c. of the syrup is only required to contain 10 grammes of ferrous iodide, so that 2.5 c.c., the quantity of syrup really operated on, should contain 0.25 gramme. As 1 gramme of ferrous iodide requires 65 c.c. $\frac{N}{10}$ AgNO_3 for complete precipitation, 0.25 gramme will require 16.3 c.c. ($65 \times 0.25 = 16.25$ c.c.).

Syrupus Ferri Phosphatis.—Prepared by dissolving iron wire in phosphoric acid by aid of gentle heat.



When solution is effected the liquid is cooled, filtered, and mixed with syrup. Sp. gr. 1·27.

One fluid drachm contains one grain of anhydrous ferrous phosphate. This preparation does not keep at all well, and it is customary to make a concentrated liquor from which the syrup can be prepared.

Iron Wire	30 grains
Phosphoric Acid, sp. gr. 1·50	$\frac{1}{2}$ fluid ounce
Distilled Water to produce	1 „ „

Dissolve by gentle heat and make up to bulk with distilled water. Allow to clarify by subsidence and decant.

One fluid part mixed with seven fluid parts of simple syrup practically corresponds to *Syrupus Ferri Phosphatis* B.P.

Syrupus Ferri Phosphatis cum Quininâ et Strychninâ (Easton's syrup).—Solution of ferrous phosphate is prepared in a similar manner to the foregoing, quinine sulphate and strychnine being afterwards dissolved in the acid solution, which is filtered into the syrup. Sp. gr. 1·280.

One fluid drachm contains one grain of anhydrous ferrous phosphate, $\frac{4}{5}$ grain of quinine sulphate, and $\frac{1}{32}$ grain of strychnine.

Syrupus Glucosi.—A mixture of liquid glucose of commerce and syrup. Chiefly used as a pill-excipient. Sp. gr. 1·365 to 1·371.

Syrupus Hemidesmi.—An infusion of hemidesmus root is prepared and filtered, in which sugar is dissolved so as to produce a syrup of specific gravity about 1·32.

Syrupus Limonis.—Lemons are peeled, the 'dummies' pressed in a wooden or well-tinned press, and the juice mixed with Spanish clay and set on one side to clarify by subsidence. Meanwhile the peel is macerated in 90-per-cent. alcohol, pressed, and filtered, the resulting tincture being adjusted to such a strength that two fluid parts represent one part by weight of fresh peel. Sugar is then dissolved in the clear juice by heat, and, when the resulting syrup has cooled, the strong tincture of lemon is added.

Sp. gr. 1·30. The syrup darkens on keeping.

Syrupus Pruni Virginianæ.—The official directions to percolate the powdered bark with water are not easy to carry out, especially during warm weather, as the percolate frequently decomposes before the end of the operation. A much more convenient and expeditious plan is to extract the drug with water by *pressure-maceration*, as

described under Syr. Sennæ. The expressed liquor having been filtered, the sugar is dissolved in it without the aid of heat and the glycerin added.

The syrup has a specific gravity of about 1.31. During maceration a small quantity of prussic acid and an oil resembling oil of bitter almonds are produced, as the result of the decomposition of a glucoside, and it is to these that the syrup owes its sedative action.

Syrupus Rhei.—The pharmacopœial process is exceedingly clumsy, as during the evaporation of the alcohol most of the aromatic principles are lost. *Pressure-maceration* again gives an excellent preparation. The powdered coriander and rhubarb are exhausted with 5-per-cent. alcohol by successive pressings until the required bulk is obtained. In this liquor, after filtration, the sugar is dissolved without heat. Sp. gr. about 1.30.

Syrupus Rhæados.—Prepared by macerating fresh red poppy petals in hot water until the colour is extracted. After expressing and filtering the liquids, sugar is added and a small quantity of alcohol. Sp. gr. about 1.29. The quantity of alcohol requires to be increased, being insufficient to prevent fermentation in summer.

Syrupus Rosæ.—This is prepared in a similar manner to the foregoing. Great care must be taken to avoid contact with iron. Sp. gr. 1.32.

Syrupus Scillæ.—Prepared by dissolving sugar in vinegar of squill. Sp. gr. 1.33.

Syrupus Sennæ.—*Pressure-maceration* is resorted to for the preparation of this syrup, and an excellent result is obtained. Heat is applied to remove albuminous matter, which if left in is liable to set up fermentation. Sugar having been dissolved in the filtered liquid, the oil of coriander is added, having been previously dissolved in a little alcohol.

Sp. gr. 1.27 to 1.30. Contrast this process with that prescribed for *Syrupus Rhei*, in which the oil of coriander is mostly dissipated by heat.

Syrupus Tolutanus.—A solution of the aromatic principles of the tolu is made by boiling with distilled water, the loss by evaporation being made up. On cooling, a crystalline deposit of cinnamic acid makes its appearance, and is removed by filtration, sugar being dissolved in the clear liquor until the syrup has a specific gravity of about 1.33.

Syrupus Zingiberis.—A strong tincture of ginger is made by percolation, two fluid parts representing one part of ginger. Of this tincture one fluid part is mixed with nineteen fluid parts of syrup.

CHAPTER XXI

COLLODIONS

Collodion is a solution of pyroxylin (di-nitrocellulose) in a mixture of alcohol and ether. It is principally employed in surgical practice. When allowed to dry on the skin it evaporates rapidly, leaving a protective film almost unaffected by water.

Flexible Collodion is similar to the foregoing, but, as its name implies, it leaves a more elastic film on drying.

Blistering Collodion is a form of liquid blister made by dissolving pyroxylin in blistering liquid.

Pyroxylin is always preserved in a damp state, moistened with either alcohol or water. In the latter case it requires to be dried at the air temperature before use. Some samples of pyroxylin are only partly soluble—due to improper nitration.

CHAPTER XXII

FIXED OILS, FATS, AND WAXES

Fixed oils and fats are obtained from both the animal and vegetable kingdoms. They are lighter than water, unctuous to the touch, and leave a permanent greasy stain when rubbed on paper. Oils and fats consist chiefly of mixtures of ethereal salts of the trihydric-alcohol glycerol and fatty acids of the acetic and acrylic series,¹ with varying proportions of *free* fatty acids and traces of colouring and flavouring principles. These fatty acids are monobasic, therefore the neutral glyceryl esters contain three acid radicals, combined with the alkyl base C_3H_5 ; an example is seen in glyceryl stearate (stearin), $C_3H_5(C_{17}H_{35}COO)_3$. Fats containing a relatively large proportion of olein are liquid, as olive oil, or soft and pasty, as lard; but if palmitin, stearin, or other higher homologues predominate, they are comparatively solid at ordinary temperatures, as mutton suet.

The waxes are chiefly composed of fatty acids combined with monohydric alcohols homologous with methyl alcohol. Spermaceti, for instance, consists almost entirely of cetyl palmitate, the palmitic ester of cetyl alcohol, $C_{16}H_{33}OH$, and beeswax of myricyl palmitate, the palmitic ester of myricyl alcohol, $C_{30}H_{61}OH$.

The composition of oils and fats varies slightly according to the processes employed in their manufacture and purification. When they contain an undue proportion of free fatty acid they are said to be rancid—a condition partly due to oxidation and partly to the fermentative action of bacteria.

Vegetable oils and fats are obtained from the seeds and fruits of plants by subjecting them to pressure, as in the case of olive, rape-seed, linseed, and cottonseed. Another method consists in extracting the bruised material with either carbon disulphide or petroleum ether, both of which, on distilling, leave the fat behind. Animal tissues rich in fat are broken up and melted alone, and the membranous portion removed by straining, as in the preparation of suet and lard.

Solubility.—All are soluble in chloroform, carbon disulphide, ether, benzene, carbon tetrachloride, and petroleum spirit. They

¹ Oleic acid, $C_{17}H_{33}COOH$, contains two atoms of hydrogen less than stearic acid, and is an unsaturated acid belonging to the acrylic series. Its lead salt is soluble in ether, a property rarely met with in other lead salts.

are only slightly soluble in alcohol, except castor oil, which is freely soluble.

Some of the oils—linseed oil in particular—when exposed to the air in thin films, absorb oxygen and become hard. These are called ‘drying oils,’ and are used for painting. Others, as olive oil, do not dry, but at most become slightly viscous. These are called ‘non-drying oils,’ and are used for lubricating machinery, etc.

All oils and fats should be kept in the dark in well-sealed vessels, and at as low a temperature as is consistent with their melting-point. The loosely capped oil bottles so commonly seen on the shelves of pharmacies are about as *unsuitable* for the preservation of fixed oils as could well be devised, as they afford every facility for oxidation.

The variation in the composition of oils and fats of undoubted purity renders sophistication comparatively easy and the detection of adulterants correspondingly difficult; in fact, the analysis of oils and fats requires great skill both in manipulation and interpretation of results. A fair idea of their value may be obtained by the application of the following tests.

1. *Specific gravity*.—In the case of oils this is taken at 15·5° C.:

Almond oil . . .	0·915–0·920	Croton oil . . .	0·940–0·960
Castor oil . . .	0·960–0·965	Linseed oil . . .	0·930–0·940
Cod-liver oil . . .	0·920–0·930	Olive oil . . .	0·914–0·919
Cottonseed oil . . .	0·922–0·930		

In the case of fats and waxes, the specific gravity is generally taken at the boiling-point of water. Fill a tared specific gravity bottle similar to fig. 21 with the melted substance, and place in a dish in which water is boiling freely. As the fat expands, it exudes by the perforated stopper. After about half an hour's boiling take out, wipe perfectly dry, cool, and weigh.

Beef suet	0·857–0·859
Cacao butter	0·857–0·858
Lard	0·860–0·861

2. *Saponification equivalent* (Koettstorfer's method).—Counter-balance a flask of about 100 c.c. capacity, and introduce 2·5 grammes of the oil or fat; then run in 25 c.c. of seminormal caustic potash in absolute alcohol, cork securely, and stand in a warm place until completely saponified. When the reaction is complete, add 1 or 2 c.c. of alcoholic solution of phenolphthalein and titrate the excess of alkali with seminormal hydrochloric acid. At the same time a blank experiment on another 25 c.c. of seminormal alcoholic potash is carried out. The difference between the two titrations, multiplied by 0·0278 (the coefficient for 1 c.c. of $\frac{N}{2}$ KOH), gives

the amount of potash in combination with the fatty acids, which, multiplied by forty, gives the percentage.

	Per cent. of KOH neutralised		Per cent. of KOH neutralised
Almond oil . . .	19.50	Olive oil . . .	18.90-19.20
Castor oil . . .	17.71-18.02	Beef suet . . .	19.80-19.98
Cod-liver oil . . .	18.51-18.52	Cacao butter . . .	19.32-19.80
Cottonseed oil . . .	19.09-19.35	Lard . . .	19.20-19.60
Linseed oil . . .	19.00-19.28		

Instead of stating the results as above, the number of grammes of oil which would be saponified by one litre of normal potash is given; in this case the term 'saponification equivalent' is employed. The most convenient way of obtaining this figure is to divide the weight of oil taken, in *milligrammes*, by the number of c.c. of normal solution of potash required for saponification.

3. *Iodine-absorption equivalent*.—It has been stated that oils and fats are chiefly composed of esters of fatty acids of the acetic, acrylic, and propiolic series. Although the relative proportion of these acids is constant within certain limits in any variety of oil or fat, the members of these groups exhibit very different behaviour towards the halogens. Under certain conditions the members of the acetic series, being already saturated, are unaffected, while those of the acrylic (oleic) and propiolic series, being unsaturated, readily combine with constant amounts, the amount being the measure of unsaturated fatty acid esters in the oil.

Hubl's solution is made by dissolving 30 grammes of mercuric chloride in 500 c.c. of absolute alcohol, and adding to a solution of 25 grammes of iodine in another 500 c.c. of alcohol. The solution should be prepared at least twelve hours before use.

Determination.—About 0.25 gramme of oil, or about 0.5 gramme of a melted fat, is weighed into a stoppered glass flask capable of holding 250 c.c. To this are added, 10 c.c. of chloroform and 25 c.c. Hubl's solution. If the liquid is turbid, chloroform must be added until perfectly clear. The flask is then stoppered, shaken up, and put away in the dark. At the same time a blank experiment, using the same volume of Hubl's solution and chloroform, is placed beside it. After twelve hours 20 c.c. of a 10-per-cent. solution of potassium iodide and 100 c.c. of distilled water are added to each bottle. Each is then titrated with decinormal sodium-thiosulphate solution, the bottle being thoroughly agitated after each addition, until the colour of the uncombined iodine has nearly disappeared. A few drops of fresh, cold starch mucilage are next added, and titration continued until the blue colour just disappears. The number of c.c. of $\frac{N}{10}$ 'hypo' used for the bottle containing the oil is deducted from that required

in the blank experiment, and the difference multiplied by 0.01259 (the coefficient for decinormal iodine). This gives the amount of iodine absorbed by the oil, and from this the percentage is calculated. The following oils and fats thus treated indicate as below :

	Percentage of iodine absorbed		Percentage of iodine absorbed
Almond oil . . .	98.0- 99.0	Olive oil . . .	79.0- 88.0
Castor oil . . .	84.0- 84.5	Beef suet . . .	34.0- 45.0
Cod-liver oil . . .	141.0-145.4	Lard . . .	52.0- 62.5
Cottonseed oil . . .	106.0-110.0	Linseed oil . . .	173.0-187.0

4. *Specific heating power* (Maumené's test).—This method depends upon the rise of temperature which takes place on mixing oils with strong sulphuric acid. Allen and Archbutt found the best strength of acid to be 97 per cent. Fifty c.c. of oil is placed in a narrow cylinder or beaker well wrapped round with flannel or lint; 10 c.c. of sulphuric acid is next added, and the mixture constantly stirred with a thermometer. When the temperature ceases to rise, a note is made. The oil and acid should both be at a temperature of 15.5° C. before mixing. The experiment is then repeated under exactly the same conditions, using water instead of oil. The rise in temperature observed with the oil, divided by that shown with the water, furnishes the specific heating power. (*Note*.—The delivery of the acid should take exactly sixty seconds.) Linseed oil should be diluted with an equal volume of liquid paraffin.

The following results have been obtained :

Water	1.00	Cottonseed oil	1.63-1.70
Castor oil	0.89-0.92	Linseed oil	3.20-3.49
Cod-liver oil	2.46-2.72	Olive oil	0.89-0.94

Oleum Amygdalæ. Almond oil. (Non-drying.) Expressed from the bitter or sweet almond. *Characters*.—Pale yellow, nearly inodorous, with a bland nutty taste. Sp. gr. 0.915-0.920. Soluble in ether and chloroform in all proportions. It does not congeal until cooled to nearly -20° C. Almond oil is sometimes adulterated with peach-kernel oil—the so-called *Ol. Amygd. Persic.* of the druggists' price-lists. When genuine oil is shaken with nitric acid and water, equal parts, a whitish mixture is produced, which after standing separates into a solid white mass and a colourless liquid. Peach-kernel oil gives a brownish-red coloration. Sesame oil may be detected by Baudouin's test. Dissolve 0.1 gramme of sucrose in 10 c.c. of strong hydrochloric acid, and add 20 c.c. of the oil. Shake thoroughly and set aside. If sesame oil is present the acid liquid acquires a crimson colour. Almond oil consists principally of olein with a very small quantity of palmitin.

Oleum Lini. Linseed oil. (Drying.) Expressed from linseed (flaxseed) at the ordinary temperatures. The yield is about 35 per cent. The oil should be perfectly clear, and of a yellowish and not reddish colour. Soluble in all proportions of turpentine, chloroform, ether, and carbon disulphide. The specific gravity is given as from 0.930 to 0.940; the author has found linseed oil pressed and filtered at a temperature of 15.5° C. to average 0.934. Hot-pressed oil is of lower gravity, ranging from 0.927 to 0.930. Congealing-point about -20° C. Linseed oil gradually thickens on exposure to the air, and if spread in a thin layer dries to a transparent varnish containing linoxin, hence its use in oil painting. The dried oil is not again soluble in turpentine. Commercial linseed oil is obtained by hot-pressing, after subjecting the ground material to the action of steam. A greater yield of oil is thus obtained, but it is dark in colour, and requires purification to remove mucilaginous matter, etc. 'Boiled oil' is obtained by heating linseed oil with lead acetate and lead oxide. Such oil dries very rapidly. The same result is brought about by blowing warm air through oil in which bags of manganese dioxide or manganese borate are suspended. In this case the manganese salt is not affected, but only appears to act as an oxygen carrier. Linseed oil is a mixture of about 80 per cent. of olein with small quantities of palmitin and myristin. On oxidation, linseed oil is nearly all converted into linoxin ($C_{32}H_{54}O_{11}$).

Oleum Morrhue. Cod-liver oil. (Semi-drying.)—Obtained from the fresh liver of the cod, *Gadus morrhua*. Although some few pharmacists still prepare it for themselves in this country, the largest quantity is imported.¹ The chief fisheries are the Norwegian and Newfoundland. The fresh healthy livers are washed free from blood with cold water, and the adhering gall-bladder is removed. Next they are placed in large steam-pans, broken up with wooden paddles, and heated to about 80° C., when the oil rises to the surface and is skimmed off. The first skimmings constitute the finest quality, and are preserved separately; afterwards the heat is raised and a second quality skimmed off. The total yield is about 48 per cent. The skimmed oil is strained through flannel, placed in large tubs, and perfectly dry salt sifted on to the surface. This as it falls carries with it most of the adhering water. Next the oil is submitted to a temperature of about -6° C., when the congealed mass is placed in bags and strongly pressed; the resulting oil is filtered, and packed in tin-lined

¹ To those who like to make an experimental batch of cod-liver oil, the following figures, taken from the author's note-book, may prove interesting:

Fresh livers taken out of cod by a local fishmonger, 5½ lb.; weight of oil obtained, 1½ lb.

After freezing in vessel surrounded by ice and salt mixture and rapid pressing, there could only be obtained about ¾ lb. of non-congealing oil, but, of course, a better yield results when working with manufacturing quantities and processes.

barrels for the market. The matter remaining in the press consists principally of stearin, and is sold for making cheap soaps. Cod-liver oil readily oxidises on exposure to air, but the amount of free fatty acid should not exceed 1 per cent.

Specific gravity varies between 0.920 and 0.930. *Saponification value*, 184.0 to 190.0. *Free acid* (as oleic), 0.46 to 0.79 per cent. *Non-saponifiable matter*, 4.12 to 6.21 per cent. *Iodine absorbed*, 141.03 to 145.41. *Average refractometer reading at 25° C.* (Zeiss), 77.2.

Cod-liver oil is freely soluble in ether and chloroform; only very slightly soluble in absolute alcohol.

A drop of sulphuric acid added to a few drops of cod-liver oil on a white slab, and well stirred, develops a violet colour, due to cholesterin. Nitric acid carefully added to some of the oil in a test-tube gives a white precipitate of albumen where the liquids meet. The Pharmacopœia requires that no stearin should separate after exposure to a temperature of 0° C. for two hours.

Meyer's test is useful because none of the fish oils used as adulterants give quite the same reaction, while many liver oils will give the cholesterin reaction with sulphuric acid. *Method of application*: Mix as required two parts of nitric acid with one part of sulphuric acid, and drop on to some of the oil on a white slab; pure Norwegian oil gives an orange-pink *before stirring*, changing to a vivid salmon-pink *after stirring*. Newfoundland oil gives a similar but less vivid reaction.

Cod-liver oil consists principally of olein, with varying proportions of stearin, palmitin, and myristin. Iodine has also been found to be present in very small quantity, probably less than two parts per million.

Oleum Olivæ. Olive oil. (Non-drying.)—Expressed from the pericarp of the ripe fruit of *Olea europæa*. The ripe fruit is reduced to a pulp in suitable mills (care being taken not to break the seeds), placed in bags, and submitted to a gradually increasing pressure. The first running constitutes the 'virgin' oil. Afterwards the press-cake is removed, treated with water, and again pressed, when oil of inferior quality is collected. A still more inferior oil is obtained by treating the press-cake with hot water and again pressing, or by pressing olives which have been allowed to ferment. The finest oil has a pale-yellow or greenish-yellow tint and a pleasant taste. Sp. gr. 0.914 to 0.919. Below 10° C. it is liable to deposit solid fats, and at the freezing-point of water it becomes dry and granular. If at this point it is submitted to strong pressure in suitable bags, it yields upwards of 70 per cent. of olein; the residue consists principally of palmitin. Oil prepared from over-ripe olives occasionally refuses to congeal even at 0° C.

Adulteration.—Sesame oil is detected by the high figure for iodine absorption and by Baudouin's test. Cottonseed oil also by the iodine absorption, which is very constant, and by the following (Becchi's) test : If 10 c.c. of olive oil is shaken with 2 c.c. of the following reagent, and then heated on a water-bath for ten minutes, a blackening, due to reduction of the silver nitrate, occurs if cottonseed oil is present :

Becchi's Reagent.—

Silver nitrate	1.00 gramme
Absolute alcohol	100.00 c.c.
Ether	20.00 c.c.
Nitric acid	1 drop

Bevan's Test, although not official, is more delicate than the above : 3 c.c. of the sample is heated to about 105° C. for half an hour with 1 c.c. of amyl alcohol and 1 c.c. of a 1-per-cent. solution of sulphur in carbon disulphide. With as little as 2 per cent. of cottonseed oil a pink coloration is produced.

It must be remembered that purified cottonseed oil, especially after prolonged heating, is most difficult of detection.

Oleum Ricini. Castor oil. (Semi-drying.)—Expressed from the seeds of *Ricinus communis*. Practically all the medicinal oil used in this country is imported, Marseilles being the seat of the pressing industry, although considerable quantities come from Italy. An enormous quantity of commercial oil comes from India, castor oil being practically the most important lubricant in all hot countries. The process consists in crushing the seeds and pressing, using a moderate application of heat. The oil is then freed from albuminous matter by heating with water, filtered, and partially bleached by exposure to sunlight. Cold-drawn castor oil is viscous, and has a yellowish tinge. It is soluble in all proportions of absolute alcohol, and in about five volumes of 90-per-cent. alcohol. The specific gravity ranges from 0.960 to 0.965. If 3 c.c. of the oil be shaken with an equal volume of carbon disulphide and 1 c.c. of sulphuric acid, the mixture should not become blackish-brown (absence of cottonseed oil). Equal volumes of castor oil and petroleum ether B.P. yield a turbid mixture if kept at 15° C., but if other fixed oils are present or the temperature is increased a clear solution is formed.

Composition.—The oil is composed of several fats, the acids of which have been the subject of repeated investigations. The principal are a solid fat closely related to palmitic acid, and a liquid one named ricinoleic acid. The press-cake has been stated to be purgative, and even poisonous, but as the Indian cattle eat it greedily without ill effect, and as a food consisting chiefly of proteids is prepared from the oil-free seeds, these statements evidently require investigation.

Possibly one or more poisonous enzymes are present which are rendered innocuous by the heat employed during treatment.

Oleum Theobromatis. Oil of theobroma.—Expressed while hot from the seeds of *Theobroma Cacao*. Cacao butter is obtained as a by-product in the manufacture of chocolate. The kernels of the seeds are crushed and pressed between hot plates, the melted fat collected, filtered through flannel, and run into moulds. The yield is about 45 per cent. Cacao butter occurs as a creamy-white solid, with a pleasant odour and bland agreeable taste. It softens at about 26° C., and melts between 31·1° and 33·9° C. Sp. gr. 0·990 to 0·998. If 1 gramme be dissolved in 3 c.c. of ether in a test-tube, and the tube be cooled to 0° C., the liquid should neither become turbid nor deposit a granular mass in *less* than three minutes (absence of paraffin, stearin, etc.); if the mixture, after congealing, be again heated to 15° C., it should gradually afford a clear solution (absence of other fixed fats). Coconut oil, which is sometimes used as an adulterant, increases the saponification equivalent, and reduces the amount of iodine absorbed. The oil consists chiefly of stearin with some olein and traces of glycerides of other acids, among which are lauric and arachidic acids. Cacao butter is used for suppositories, as, while having a melting-point below that of the human body, it is sufficiently firm to be handled.

Adeps. Lard.—The perfectly fresh fat of the abdomen of the hog, *Sus scrofa*, known as 'flare,' is freed as far as possible from the adhering membrane, after which it is cut into small pieces and kneaded in running water until free from blood, etc.; during this process much of the animal odour is got rid of. After being allowed to drain, the fat is melted in a steam-pan and stirred occasionally to facilitate evaporation of the adhering water, when it is strained. The yield is about 90 per cent. of the 'flare' taken. Lard prepared as above is pure white and possesses but little odour. At summer temperatures it remains firm and is easily handled. Much of the lard, however, imported into this country is made from all the fatty portions of the hog, and varies in consistence, some varieties being almost fluid at summer temperatures, while others are too hard. In the latter cases there is little doubt that some of the olein has been removed by expression, or that stearin has been added. *Benzoated lard* is prepared by digesting powdered benzoin with melted lard, when some benzoic acid and traces of essential oil pass into solution. Lard is a mixture of olein with about 40 per cent. of solid stearin and palmitin. At a temperature of 0° C. the last two may be obtained by expressing strongly in bags; the olein thus separated is known as *lard oil*. Knowing this, the importance of stirring melted lard until perfectly cold becomes apparent; but in spite of this precaution, if lard is kept

for any length of time in a cold place, the solid fat assumes a crystalline character, the whole presenting a crumbly granular appearance. The melting-point of lard varies, but it should be about 38°C . Cottonseed oil, which is the only likely adulterant, may be tested for by Bevan's or Becchi's test as described under Olive Oil.

Adeps Lanæ. Wool-fat. Anhydrous lanolin.—Fat obtained from sheep's wool has been known and recommended in skin affections from very early times. The processes employed in its purification are based on Schulze's method. The fat obtained by treating the natural greasy wool with soap liquor is decomposed with a mineral acid. This crude wool-fat contains about 70 per cent. of cholesterin and ischolesterin and about 30 per cent. of fatty acids. The first purifying operation consists in saponifying the fatty acids with caustic soda. An emulsion of the cholesterin compounds in the soap is thus obtained, which on dilution gives the so-called wool 'milk.' When this wool milk is submitted to centrifugal action it separates into 'cream' and 'skim-milk.' The 'cream,' on precipitation by a lime salt, yields crude lanolin. This is heated, water separating, and the wool-fat is further purified from waxy matter.

The chemical composition of wool-fat is very complex. In a crude state its constituents are the monatomic alcohols cholesterin and ischolesterin. These exist partly free and partly as stearate and palmitate. The odour of crude wool-fat is due to volatile acids, chiefly capric and caproic, which are always found in sweaty secretions. There have also been found ceryl cerotate and its homologues, and probably cholesteryl cerotate as well as small proportions of the glycerides of the lower fatty series. It is important to note that the Pharmacopœia requires purified wool-fat to be almost free from uncombined fatty acids. Wool-fat cannot properly be called a *fat*, as it is not a glyceride. It does not form soaps when boiled with aqueous solutions of the alkalies, but it has the peculiar property of forming emulsions with alkaline solutions.¹

The pharmacopœial test for cholesterin with sulphuric acid is indefinite, and the author prefers to rely upon a reaction devised in his laboratory some years ago. This consists in dissolving 0.01 gramme of wool-fat in 5 c.c. of chloroform and 0.5 c.c. of acetic anhydride. If the mixture is carefully poured upon a few c.c. of sulphuric acid contained in a test-tube so as to avoid admixture, a purplish ring slowly appears at the point of contact, while the upper layer turns a bright green, the colours persisting for some time.

When water is incorporated with pure wool-fat to the extent of 30 per cent., it constitutes *Adeps Lanæ Hydrosus*. This is not, however, the full extent to which water is taken up, as, if added in small

¹ Wool-fat may be hydrolysed with boiling alcoholic potash.

quantities at a time, there is no difficulty in incorporating at least an equal weight.

Wool-fat is too sticky to be used as an ointment base alone, but when mixed with an equal weight of lard or soft paraffin it is frequently of great service, particularly when large amounts of liquids are required to be incorporated.

Cera Flava. Yellow beeswax.—A secretion of the hive bee, *Apis mellifica*. It is generally looked upon as a conversion product of sugar, and not derived directly from the flowers on which the bee feeds. The wax is formed in very thin scales between the rings of the thorax, and is used in the construction of the comb. This comb, filled with honey, is taken from the hives at certain intervals, broken up, and placed in muslin bags when the honey drains away. The wax is purified by melting in water, dried, and run into moulds. *White wax* is ordinary beeswax that has been melted in dilute alum-water, spun out into ribbons, and bleached by the sun or by chemical means; when it has acquired the requisite degree of whiteness it is re-melted, washed with hot water, and moulded into cakes. By this bleaching process wax loses its fragrance and acquires a rancid odour; otherwise it is unaltered in composition. Beeswax consists of cerotic acid, a homologue of acetic acid, and about 80 per cent. of myricin, the palmitic ester of myricyl alcohol, a homologue of ethyl alcohol.

Beeswax is readily and completely soluble in hot oil of turpentine. Specific gravity ranges between 0.960 and 0.970, and melting-point from 62.5° to 64° C., the solidifying-point being two or three degrees lower. Beeswax is very frequently adulterated, the most common adulterant being hard paraffin. Flour or any other added powders remain insoluble on boiling with turpentine. Stearic acid is soluble in boiling alcohol, beeswax only slightly. Stearin, stearic acid, Japan wax, etc., are saponified when warmed with aqueous solution of potash. Beeswax requires to be boiled with *alcoholic potash* before hydrolysis is effected. Paraffin may be detected by heating with strong sulphuric acid in large excess. This carbonises beeswax, but does not affect paraffin. After cooling, the black mass is washed with water to remove acid, dried, and extracted with ether, which on evaporation leaves the paraffin in a weighable condition. Five grammes of beeswax melted in 20 c.c. of boiling alcohol should require for neutralisation not less than 1.6 c.c. alcoholic $\frac{N}{1}$ KOH, using phenolphthalein as indicator; and upon the addition of 20 c.c. more volumetric solution and boiling for one hour under a reflux condenser, not less than 6.2 and not more than 6.8 c.c. should be found uncombined when titrated back with $\frac{N}{1}$ H₂SO₄ (absence of paraffin and foreign fats).

Cetaceum. Spermaceti.—The solid portion of the oil found in a cavity of the head of the sperm whale, *Physeter macrocephalus*. While the whale is alive the oil is in a fluid condition, but soon after the animal is killed the oil becomes pasty. In this condition it is placed in bags to drain, and finally submitted to pressure in the cold, when most of the liquid (sperm oil) comes away. The residue, consisting of impure spermaceti, is then boiled with very dilute alkali, and afterwards well washed. Commercial spermaceti occurs as a white scaly-crystalline brittle mass. When used in ointments it is generally combined with beeswax to modify this tendency to crystallise. Spermaceti consists principally of cetyl palmitate (cetin), with small quantities of the salts of lauric, stearic, and myristic acids. When cetyl palmitate is saponified with an alkali it yields ethal (cetyl alcohol), and not glycerin (glyceryl hydrate).

Spermaceti melts between 46° and 50° C. It is freely soluble in hot ether, chloroform, and the fixed and volatile oils. It should be almost neutral, not more than five drops of $\frac{N}{1}$ KOH being required to neutralise 1 gramme when dissolved in 20 c.c. of warm 90-per-cent. alcohol. This test ensures the absence of stearic or palmitic acids.

Serum Præparatum. Prepared suet.—Mutton suet consists of the purified fat from the abdomen of the sheep, *Ovis aries*. It is prepared in a precisely similar manner to lard, the great object being to free the fat as completely as possible from blood and adhering membrane. Suet is generally credited with poor keeping properties, but if carefully prepared, and preserved in clean jars out of contact with the atmosphere, the author finds that it keeps almost as well as lard. The chief pharmaceutical use is for mercurial ointment and for cantharides plaster, but it occasionally finds employment in pomatums for the hair, besides being used in extracting the perfumes of flowers. The melting-point of mutton suet is about 46° C. when freshly prepared, but old samples may not melt much below 49° C. In the 1885 Pharmacopœia the melting-point was erroneously given as 39.5° C., which is that of beef suet.

Hydrocarbons

Paraffinum. Paraffin.—The Pharmacopœia enumerates three varieties of paraffin—viz., hard, soft, and liquid. *Hard paraffin* is prepared from the higher boiling fractions of the tar obtained by the destructive distillation of Scotch shale or cannel coal. The tar is purified by treatment with sulphuric acid and afterwards with soda solution, when, after washing, it is redistilled. The successive fractions, naphtha, burning and lubricating oils, are collected first; the last fraction contains the paraffin wax, which deposits on cooling. This

is separated by pressing in the cold, purified, and redistilled, the final colour being removed by filtration, while hot, through bone black. Paraffin wax should be colourless and odourless, and have a crystalline structure; sp. gr. 0.820 to 0.940; melting-point from 54.4° to 57.2° C. A hot alcoholic mixture should not redden litmus (absence of acid).

Soft paraffin consists of a mixture of solid and liquid hydrocarbons obtained in the distillation of petroleum, the former of which are entirely without crystalline structure. It is purified in a manner analogous to that described under *Hard Paraffin*. Like paraffin wax, it consists almost entirely of saturated hydrocarbons, the small quantity of oxygen-containing compounds being almost negligible. Mixtures of paraffin wax with semi-liquid hydrocarbons are sometimes represented as soft paraffin, but they always present an unusual appearance with widely diverging melting-points. Soft paraffin should melt between 35.5° and 38.9° C. The specific gravity at the melting-point varies from 0.840 to 0.870.

Liquid paraffin is obtained from petroleum after the more volatile portions (benzolene, etc.) have been removed by distillation. The oil is first freed from water by blowing warm air through, and then treated with sulphuric acid. After the evolution of sulphur dioxide (due to the decomposition of impurities in the oil) has ceased, the acid is allowed to settle, drawn off, and the oil washed with solution of soda, and finally with warm water. Liquid paraffin should be colourless and free from fluorescence. Boiling-point not less than 360° C. The specific gravity is required to be not less than 0.885, but this is commercially unobtainable. Moreover, liquid paraffin is largely used as a solvent for medicaments to be applied in the form of a spray to the nose and throat, and experience has shown that a specific gravity of 0.865 is more useful.

The samples of soft and liquid paraffin met with in commerce are frequently contaminated with sulphur, and are therefore unsuited for internal use, especially when combined with hypophosphites.

Test.—Take of the suspected sample 4 c.c., absolute alcohol 2 c.c.; shake in a test-tube, and add 1 c.c. of pure hydrochloric acid and a fragment of pure zinc. A cap of white filter-paper wetted with solution of lead oxyacetate is fastened over the mouth of the tube, spurting being prevented by a plug of cotton wool. The presence of sulphur compounds is indicated by the paper turning brown or black. The hydrogen evolved in contact with *pure* paraffins has a pleasant ethereal odour, which the presence of even a trace of sulphur modifies in a marked degree.

The origin of petroleum is unknown, but the formation is supposed to take place in the lower layers of the earth's crust containing fossil remains of sea animals, etc. Another theory suggests petroleum to be formed as the result of the action of steam under great pressure

on the metallic carbides which are supposed to exist in the earth's interior. Crude petroleum is specifically lighter than water, and varies greatly in consistence and colour, generally appearing as a thick yellow or brown liquid, shading green when viewed by reflected light (fluorescence¹).

The paraffins, as the derivation *parum affinis* implies, are characterised by their stability. At ordinary temperatures they are not acted upon by nitric acid, sulphuric acid, caustic alkalies, or such powerful oxidising agents as chromic acid or potassium permanganate, and even at high temperatures only a very slow action takes place. It is owing to this inertness that the paraffins have come into such universal use in pharmacy, as although it is known that the softer paraffins absorb oxygen in a slight degree, yet the amount is too small to have any appreciable effect on the keeping properties of ointments prepared with them.

¹ By fluorescence is signified the property, which many substances possess, of converting the ultra-violet rays of the spectrum into visible rays of light.

CHAPTER XXIII

OINTMENTS

The ointments of the Pharmacopœia may be divided into two classes: (A) those containing medicaments intended for absorption, such as aconitine; (B) those used as dressings for wounds or sores, of which boric acid ointment may be taken as a type.

Class A requires a basis having a melting-point about 37° to 39° C., capable of ready absorption when rubbed into the skin, and which, while free from any tendency to set up irritation, possesses well-marked keeping properties. Pure fresh lard fulfils all these requirements. Benzoated lard, although keeping well, is occasionally irritating to tender skins, and is especially unsuitable for eye ointments. Class B also requires a non-irritant basis, softening but not melting at the temperature of the human body, so as to avoid the inconvenience caused by the ointment soaking into the bandages. The basis must, however, not be so hard that it cannot be spread readily on lint, etc. A mixture of solid and semi-solid hydrocarbons, such as Unguentum Paraffini, fulfils all these conditions, Unguentum Cetacei scarcely any, and it is difficult to understand why the latter should have been retained in the Pharmacopœia.

Class A

Unguentum Aconitinæ contains 2 per cent. of alkaloid

„	Atropinæ	„	2	„	„	„
„	Cocainæ	„	4	„	„	„
„	Veratrinæ	„	2	„	„	„

Alkaloidal ointments.—An oleate of the alkaloid is first prepared, and this mixed with the lard. If benzoated lard is used the ointments turn brown on keeping.

Unguentum Aquæ Rosæ.—This is intended to represent cold-cream, but the formula is not a good one.

Unguentum Belladonnæ.—Prepared by mixing a concentrated liquid extract with benzoated lard. The product contains 0.6 per cent. of alkaloid.

Unguentum Cantharidis.—The bruised cantharides are digested

with the benzoated lard at a temperature of about 50° C. for twelve hours, strained, and pressed, the ointment being stirred until cold. Only a portion of the cantharidin is removed by this treatment.

Unguentum Capsici.—Prepared by digesting capsicum fruits in olive oil; this dissolves out the oleo-resin. This ointment must not be stirred while cooling, as it is intended to present a crystalline appearance.

Unguentum Cetacei.—A benzoated mixture of spermaceti, white wax, and almond oil. Peach-kernel oil, besides being unofficial, produces a dark-coloured ointment.

Unguentum Chrysarobini.—Prepared by triturating chrysarobin with hot benzoated lard and continuing the stirring until cold. Most of the chrysarobin comes out again on cooling.

Unguentum Conii.—Conium juice is evaporated on a water-bath to one-eighth its volume and incorporated with hydrous wool-fat. On keeping this ointment becomes mouldy. This may be prevented by benzoating the wool-fat or adding two or three drops of oil of clove to each ounce.

Unguentum Gallæ cum Opio.—To obtain this ointment perfectly smooth, the opium should be moistened with a little water before mixing with the fat. It contains 7·5 per cent. of opium.

Unguentum Hamamelidis.—A mixture of liquid extract of hamamelis and hydrous wool-fat.

Unguentum Hydrargyri.—The manufacture of this ointment is a very tedious process. In order to obtain it of good colour, as well as to facilitate the extinction of the mercury, the latter should be first triturated with a little mercury oleate prepared according to the 1885 Pharmacopœia. Another plan is to use old and rancid mercury ointment for this purpose.

Unguentum Hydrargyri Compositum.—The camphor should not be added until the melted mixture of beeswax and olive oil is cooling; the mercury ointment should be incorporated when the mixture is just warm enough to enable admixture to be carried out by stirring. If added too soon there is danger of the mercury separating.

Unguentum Hydrargyri Iodidi.
Unguentum Hydrargyri Subchloridi. } —Are simple admixtures.

Unguentum Hydrargyri Oleatis.—Prepared by mixing mercury oleate with benzoated lard. Mercury oleate is directed to be prepared by decomposing an emulsion of oleic acid and solution of hard soap, with solution of mercuric chloride. An insoluble precipitate of mercuric oleate, with some palmitate and stearate, is formed, which is washed and dried on a water-bath.

Unguentum Iodi.—The iodine is first dissolved in a mixture of glycerin and potassium iodide. This ensures even distribution. *Avoid use of steel knives.*

Unguentum Picis.—A simple admixture of tar and beeswax.

Unguentum Potassii Iodidi.—A solution of potassium iodide and potassium carbonate in water is made first, which is then added by degrees to the benzoated lard. The potassium carbonate is introduced to neutralise the acidity of the lard, which might otherwise liberate iodine from the iodide.¹

Unguentum Resinæ.—A simple admixture.

Unguentum Staphisagriæ.—This ointment is only used as an insecticide. A simpler process than the official one would be to dissolve the correct proportion of stavesacre oil in the stiffened lard.

Unguentum Sulphuris.—This ointment loses its colour on keeping, and, judging from the prescriptions of skin physicians, is too strong.

Unguentum Sulphuris Iodidi.—To ensure even admixture the iodide is first dissolved in glycerin. *Avoid use of steel knives.*

Unguentum Zinci.—A simple admixture.

Unguentum Zinci Oleatis.—The zinc oleate is prepared by decomposing solution of hard soap (sodium oleate principally) with solution of zinc sulphate. The precipitated zinc oleate is collected, drained, washed with hot water, dried, and mixed with an equal weight of melted soft paraffin. To obtain the oleate with as little odour as possible, *fresh* olive oil soap must be used. The evil-smelling *Sapo Cast. Exot.* which is commonly sold as 'hard soap B.P.' yields a most unsatisfactory article.

Class B

<i>Unguentum Creosoti.</i>	} —Prepared by simple admixture. They are but little used.
<i>Unguentum Eucalypti.</i>	
<i>Unguentum Glycerini Subacetatis.</i>	

Unguentum Hydrargyri Nitratis Dilutum.—Consists of nitrate of mercury ointment diluted with soft yellow paraffin. It does not keep well if made from old ointment, and should be prepared freshly.

<i>Unguentum Hydrargyri Oxidi Flavi.</i>	} —Are simple admixtures.
<i>Unguentum Hydrargyri Oxidi Rubri.</i>	
<i>Unguentum Iodoformi.</i> ²	
<i>Unguentum Plumbi Acetatis.</i>	
<i>Unguentum Plumbi Carbonatis.</i>	
<i>Unguentum Plumbi Iodidi.</i>	

Unguentum Acidi Carbolici.—The glycerin is added to prevent the phenol crystallising out, as sometimes happens if simply dissolved in the melted hydrocarbons.

¹ The Pot. Carb. should be increased.

² Iodoform ointment made with a paraffin basis turns red on the surface when exposed to light. This is due to liberation of iodine. The ointment exposed to air in the dark is said not to be affected. When prepared with lard there may be no apparent change, as the liberated iodine in time combines with the fat.

Unguentum Acidi Salicylici.—Avoid use of steel knives during preparation, or the ointment may acquire a pinkish tint from formation of ferric salicylate.

Unguentum Hydrargyri Nitratis.—When mercury is dissolved in cold nitric acid, a green mixture is formed containing mercuric and mercurous nitrate with free acid. When this mixture is poured into the hot fats, violent decomposition takes place, nitric oxide being given off; a portion of the fat is oxidised to elaidin, a solid body which is without action on the mercuric nitrate formed. If any mercurous



FIG. 143.—OINTMENT-MILL.

nitrate is left, the ointment, instead of retaining its pale lemon colour, soon darkens from separation of metallic mercury.

The great secret in making this ointment, lies in the strict observation of the temperatures. The lard and oil should be heated together in a porcelain dish, on a sand-bath, to a temperature of 148° C. While this is proceeding, an earthenware jar capable of holding ten times the quantity is made as hot as possible by standing in water. When the hot fats are poured into the jar, the temperature begins to fall, and when it has dropped to 143° C., the acid solution is added, a little at a

time, the mixture being briskly stirred with a glass rod. It is important to stir the ointment while cooling, both to get rid of fumes and to obtain a uniform product. If larger quantities than those given in the Pharmacopœia are operated upon, the temperature of the melted fats may be safely lowered by 10° C.

Unguentum Paraffini is a mixture of hard and soft paraffins. In very warm weather or in the tropics, it is permissible to increase the proportion of hard paraffin, so as to obtain an ointment of convenient melting-point, while in the winter or in cold climates the proportion may be correspondingly reduced. It will be noticed that wherever possible a white ointment is to be made, and for this reason *white* soft paraffin is most generally used, the yellow variety only being employed for coloured ointments, such as that of mercuric oxide.

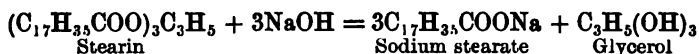
No especial precautions need be observed in melting the two paraffins, but to obtain a perfectly smooth and homogeneous mixture when cold needs great attention. If possible, the cooling should be accomplished in a shallow dish, and as soon as the mixture shows the slightest tendency to congeal, it should be stirred with a broad-bladed spatula, the solidifying portions at the edge being constantly scraped down and intimately mixed with the more fluid mixture in the centre of the dish.

Milling of Ointments.—The great difficulty experienced in turning out smooth ointments on a large scale has led to the introduction of milling. The mills commonly employed are constructed on the edge-runner principle (fig. 143) the ingredients being first mixed in a porcelain-lined hopper before being ground between the surfaces of revolving millstones, capable of being regulated for coarse or fine work. The output of such a mill as that illustrated is from 40 to 50 lb. per hour.

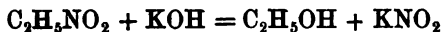
CHAPTER XXIV

SOAPS

As has been stated before, the fixed oils and fats principally consist of glyceryl esters of oleic, stearic, and palmitic acids. When these are boiled under suitable conditions with caustic alkalies, they are decomposed or saponified, the *hard soaps* being sodium salts, and the *soft soaps* potassium salts.



The term *saponification*, although originally used in the above sense, is now employed to describe the decomposition of any ester into an alcohol and an acid by water, usually in the presence of weak alkali or acid, although the more correct term is *hydrolysis*. Thus it will be seen that ethyl nitrite is saponified or hydrolysed by an alkali in precisely the same manner as the glyceryl stearate (stearin) just described :



Sapo Animalis.—Curd soap is made from animal fat (tallow) and caustic soda. It contains from 25 to 30 per cent. of water, which it loses on heating to 60° C. for some time. To hasten drying, the soap is first reduced to shavings by a rotary planing machine, and the shreds are placed in shallow trays in a warm room, the moist air being continually removed by a fan. Curd soap is scarcely soluble in cold, but dissolves freely in hot water, the solution always having an alkaline reaction. This is accounted for by ionisation that takes place becoming more pronounced in very dilute solutions. To determine the neutrality of the soap the Pharmacopœia therefore orders it to be dissolved in boiling alcohol in which liquid the soap is stable. The separated fatty acids melt between 45° and 50° C.

Sapo Durus.—Hard soap, commonly known as Castile soap.—This is directed to be made from olive oil and caustic soda, although most of the inferior qualities are made from cottonseed oil. The separated fatty acids melt at about 25° C., otherwise it should correspond with the characters given for curd soap.

Sapo Mollis.—Soft soap is ordered to be made with olive oil and caustic potash, but all kinds of oils are used in the preparation of the cheaper varieties. The green colour should be due to chlorophyll naturally present in the oil, but it is undoubtedly added during the process of manufacture, as a large proportion of genuine olive oils are yellow, and not green.

Soft soap differs from the other soaps in that the glycerin and impurities, instead of being left behind in the 'salting-out' process, are included in the finished soap, as on the addition of sodium chloride to a potash soap, it is decomposed, sodium (or hard) soap and potassium chloride being formed.

Soft soap is readily dissolved by warm alcohol, and does not separate again on cooling.

Mottled Castile soap, which is still to be found in many pharmacies, is made by adding ferrous sulphate to the cheap white variety just before cooling. When freshly cut, the soap has a blue-and-white appearance, but on exposure the iron becomes oxidised, and a mottled red appearance is assumed.

Toilet soaps are generally prepared by remelting a good-class raw soap and perfuming, or by cutting bar soap into shreds, milling between granite rollers, and perfuming. In either case the perfumed soap is formed into bars, divided again into blocks of equal weight, and stamped in a soap press, any lettering being done at the same time. This last machine gives the tablets their usual trade forms.

Transparent soap.—The best kinds of transparent soap are generally prepared by intimately mixing the *warm* fatty materials (of which castor oil is a considerable ingredient on account of its ready saponifiability and its tendency to form translucent soap) with soda ley of about 1·3 sp. gr. and a small proportion of alcohol. Any colouring matter and scent are then added and the whole allowed to stand until saponification is complete. Some makers of cheap transparent soaps use cane sugar in place of alcohol. This is strongly deprecated, as the saccharine matter is irritating to sensitive skins.

In the preparation of soap by this 'the cold process' it is interesting to note that the fatty materials and ley are only warmed to about 45° C., sufficient heat being generated by the reaction to complete saponification.

Medicinal soaps.—Ammonia soap is formed in the preparation of Linimentum Ammoniaë; lime soap in Linimentum Calcis; lead soap in Emplastrum Plumbi; mercury soap in Hydrargyri Oleas, and zinc soap in Zinci Oleas. These are dealt with under the respective headings of Liniments, Plasters, and Ointments.

Medicated soaps.—The use of medicated soaps is now largely advocated by many members of the medical profession, and while it would hardly repay the pharmacist to manufacture all the soaps that are so frequently prescribed, yet instances constantly occur when only two or three tablets of a special kind are ordered, and it is to the credit of the dispenser if these can be prepared at short notice.

Mix powdered curd soap and hard soap in equal proportions, and label 'soap powder.'

Example.—Ichthyol 5 per cent. ; sulphur 10 per cent. ; tar $2\frac{1}{2}$ per cent.

Soap Powder	80 parts
Precipitated Sulphur	10 „
Ichthyol-ammonia	5 „
Stockholm Tar	$2\frac{1}{2}$ „
60-per-cent. Alcohol	10 „

Mix the soap and sulphur intimately and pass through a sixty-hole sieve into a convenient-sized mortar ; add the ichthyol mixed with half the alcohol, and the tar previously shaken up with the remainder ; mix thoroughly and beat up to a uniform mass. Weigh off into pieces of four ounces each, and stamp, either with a soap press or a home-made machine similar to that described below.

Fig. 144, *a*, is an oval collar, preferably made in stout brass, $4\frac{1}{2}$ inches deep. In section the collar should be that of an oval soap cake.

Fig. 144, *b*, is a mahogany or metal block, one inch thick, made to fit accurately into the collar, and provided with a flange at the bottom. The upper surface of the block should be hollowed out, so as to impart the usual convex surface to the soap tablet.

Fig. 144, *c*, is similar to fig. 144, *b*, but may be about six inches long and without a flange, the under surface being scooped out so as to correspond.

To use, place the soap mass, which should weigh about four ounces, in the cylinder previously fitted over the bottom block, and, having inserted the plunger, place the whole in an ordinary tincture-press and squeeze until a firm tablet results. The inside of the mould should be oiled before using.

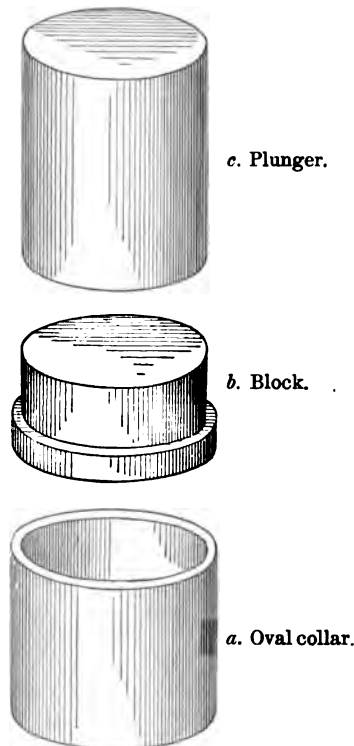


FIG. 144.

CHAPTER XXV

PLASTERS

Emplastrum Ammoniaci cum Hydrargyro.—Sulphurated oil is prepared by triturating sulphur with very hot olive oil. When the mixture is cool the mercury is added and triturated until globules are no longer visible to the naked eye. This does not take long, since each globule as it separates becomes coated with a film of sulphide which prevents it from coalescing with its fellows. It should be noted that the ammoniacum is purified by straining in hot water and afterwards evaporated again.

Emplastrum Belladonnæ.—Contains 0·5 per cent. of alkaloid. The alcohol is distilled off the liquid extract before incorporating with the resin plaster. Only very *pale* liquid extract should be used, otherwise the resulting plaster will turn out too dark.

Emplastrum Calefaciens.—This is not intended to be a blistering plaster, but a stimulant, the cantharides only being partially exhausted by infusing with boiling water.

Emplastrum Cantharidis.—The cantharides must be in the *very finest powder*, otherwise the fragments of the wing-sheaths will show up in the finished plaster.

Emplastrum Hydrargyri.—The mercury is ‘killed’ in a similar manner to that prescribed for Emp. Ammon. cum Hydrarg.

Emplastrum Menthol.—A temperature of 70° C. should not be exceeded.

Emplastrum Opii.—Contains 10 per cent. of opium, which must be in the *finest powder* or it will show in the finished plaster. Some makers rub the opium up with water before adding to the resin plaster, heating it afterwards to drive off the moisture.

Emplastrum Picis.—To make a nice plaster the ingredients require to be strained before evaporating.

Emplastrum Plumbi.—Consists principally of lead oleate with a little stearate and palmitate. Its preparation requires a good deal of care. The litharge must be in fine powder, and should be sifted into the vessel containing the oil and water. The mixture is then boiled and frequently stirred to prevent the lead oxide settling at the bottom. As water is lost by evaporation, more should be added as required,

to prevent overheating and darkening of the plaster. If the operation is carried out in a pan heated by a steam-jacket, this risk is practically obviated. In fact, with care, lead oxide decomposes olive oil without the presence of water at all, but the resulting plaster is rarely of a good colour. As the boiling continues, the contents of the vessel lose their red colour, and gradually become white. When this has taken place heat is continued for an hour or so longer, or until a little of the mixture removed from the pan and cooled is no longer sticky when kneaded between the fingers. When finished, the plaster is allowed to cool, after which it is taken out and kneaded in clean water to remove the glycerin. Lead plaster as it leaves the pan is of a greyish-white colour, but if it is kneaded and 'pulled' for some time it appears yellowish white. It is usual to roll the plaster into sticks of eight ounces each, and, after leaving in a trough of cold water until set, to wrap them in calico. The yield is a little more than the weight of oil and oxide taken.

Lead plaster may also be obtained by decomposing solution of hard soap with acetate of lead, but the product is very brittle, and soon darkens on keeping. When powdered it is sometimes ordered for dusting, in certain skin affections.

Emplastrum Plumbi Iodidi.—The lead iodide should be in very fine powder, and must not be added until the plaster is beginning to cool.

Emplastrum Resinæ.—The resin must be melted and strained before adding to the lead plaster and soap.

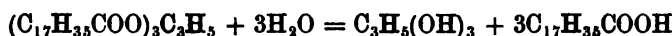
Emplastrum Saponis.—This only differs from the foregoing in the proportions, and the same remark as to the straining of the resin applies.

CHAPTER XXVI

GLYCERINS

Glycerin (Glycerol or Propenyl Alcohol, $C_3H_5(OH)_3$) is a trihydric alcohol which is present as an ester of oleic, stearic, and palmitic acids in fats and oils. It is obtained as a by-product in the manufacture of soap and candles by the saponification or hydrolysis of the fats.

Glycerin obtained from soap leys is very impure. Purification is carried out by neutralisation, precipitation, concentration, etc., after which it is distilled in superheated steam, decolourised by filtering through animal charcoal, and redistilled under reduced pressure. A much purer glycerin is obtained in the preparation of fatty acids for candle-making, by heating fat under pressure with water containing a small proportion of lime, when it splits up as follows :



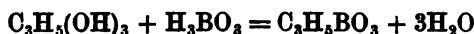
The liquor, or 'sweet water,' after purification in a manner similar to that described above, yields pure glycerin.

Tests, etc.—Glycerin is very hygroscopic, and should always be preserved in stoppered bottles. The loosely capped bottles used in many pharmacies are most unsuitable, as the glycerin absorbs water from the atmosphere and gradually becomes weaker. The impurities most likely to be found in glycerin are butyric acid, iron, copper, and arsenic. Butyric acid may be detected by the characteristic odour evolved on heating with dilute sulphuric acid and alcohol; iron and lead by the usual tests. Arsenic must be sought for carefully, as it is easily missed when present in small traces. Gutzeit's test is generally employed :

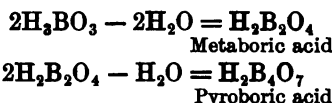
Glycerin 2 c.c., when diluted with 5 c.c. of a mixture of one part of hydrochloric acid (pure) and seven parts of water and added to 1 gramme of zinc in a long test-tube, the mouth of which is covered with a cap of filter-paper moistened with solution of mercuric chloride and dried, should not afford a yellow stain after fifteen minutes. *Precautions.*—Use a long test-tube and near the top insert a plug of cotton wool which has been dipped in lead-acetate solution, squeezed, and dried. This will prevent spurting and also intercept H_2S formed by any trace of sulphate present

as an impurity ; always set on a blank experiment, so as to check the purity of the reagents used.

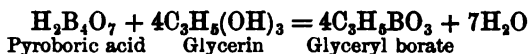
Glycerinum Acidi Borici.—Prepared by heating glycerin with boric acid (orthoboric). During the operation some of the glycerin is decomposed owing to the high temperature employed, the boric acid meanwhile losing sufficient water to suggest the formation of glyceryl borate :



As the water is lost at temperatures which practically correspond with the successive formation of metaboric and pyroboric acids, the reactions might be expressed as follows :



Then



That this is not improbable is evidenced by the fact that pyroboric acid, dissolved in glycerin by the aid of heat, practically yields glycerin of boric acid B.P., scarcely any glycerin being decomposed in the process other than that involved in the reaction. Moreover, owing to the short time the preparation is exposed to a high temperature, it can be prepared without darkening in colour.

When dissolved in water glyceryl borate splits up, glycerin and boric acid being regenerated.

Glycerinum Acidi Carbolici.—Contains one part of phenol in five fluid parts.

Glycerinum Acidi Tannici.—Contains one part of tannic acid in five fluid parts. For the manufacture of this preparation the glycerin must be free from even the minutest trace of iron, otherwise a dark-coloured preparation will result. In any case, on long keeping, the colour will always be found to deepen.

Glycerinum Aluminis.—The ordinary powdered alum of trade contains a good deal of oxysalt, due to the high temperature employed in drying before grinding, and when used in the preparation of this compound it yields a turbid solution which is difficult to clarify. If, however, *freshly powdered clean crystals* are taken and dissolved in the water, previously heated to boiling, before adding the glycerin, the resulting preparation only requires straining through muslin.

Glycerinum Amyli.—A translucent jelly obtained by heating the starch with the glycerin and water. The starch should be evenly mixed with the water before adding the glycerin, so as to ensure the absence of lumps, and the mixture must be constantly stirred.

Glycerinum Boracis.—At first sight it might appear that when borax, $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$, is dissolved in glycerin, it would react in a similar manner to *Glyc. Ac. Boric.*, the only difference being the production of caustic alkali instead of water. But, esters being so readily saponified, the formation of glyceryl borate in presence of a strong alkali is precluded, hence the assumption that the official article is only a solution of borax in glycerin.

Mel Boracis.—Although strictly speaking not a glycerin, borax-honey may be mentioned here, because of its close analogy to glycerin of borax—honey consisting principally of dextrose, which is regarded as a polyhydric alcohol.

Glycerinum Pepsini.—Made as directed by the Pharmacopœia, a somewhat turbid, dark-coloured, and very strongly smelling preparation is formed. The official pepsin is only required to dissolve 2500 times its weight of white of egg in six hours. Although pepsin of this strength may seem very active, no difficulty is experienced in making much stronger grades. To obtain a pale-coloured article with the slightest possible odour, pepsin of at least 1 to 5000 should be employed—of course in relative proportion—and the final product adjusted so that one fluid drachm will dissolve 12,500 grains of white of egg when tested under the proper conditions.

Glycerinum Plumbi Subacetatis.—The pharmacopœial process is unsatisfactory, producing a turbid brownish liquid which is very difficult to clarify. Lothian suggested the following cold process, which with care yields a clear and colourless preparation :

Lead Acetate, in powder	.	.	25 parts by weight
Litharge,	"	"	17.5 " "
Glycerin	.	.	126 " "
Distilled Water	.	.	60 " "

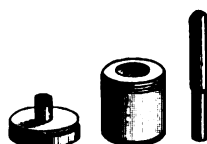
Rub the salts with fifteen parts of the water to a paste and allow to stand for twelve hours, stirring occasionally. Add the remainder of the water and the glycerin, and allow to stand for twenty-four hours, stirring at intervals. Filter. Evaporate the filtrate (which has a specific gravity of about 1.33) on a water-bath to sp. gr. 1.48. The product is about 102 parts by weight.

Glycerinum Tragacanthæ.—A mixture made by rubbing powdered tragacanth with glycerin and water.

CHAPTER XXVII

COMPRESSED TABLETS

One of the most notable features of modern pharmacy has been the introduction of compressed drugs. Compressed tablets are prepared by squeezing the material between suitable dies into a disc-like or lenticular form. Until comparatively recently their production has been almost entirely in the hands of manufacturers, but the moderate cost at which serviceable machines can now be obtained enables the pharmacist to prepare them for himself.

FIG. 145.—HAND
TABLET-MOULD.

The simplest form of tablet apparatus is shown at fig. 145. It is made of steel, and consists of a cylinder and two accurately fitting dies, the faces of which are hollowed out so as to impart the familiar



FIG. 146.—TABLET-MACHINE.

lenticular appearance. The cylinder is placed over the bottom die, the medicament introduced, the upper die inserted, and the operation completed by striking it a smart blow with a hammer.

Fig. 146 shows a double-acting, semi-automatic hand-power machine, capable of turning out from eighty to a hundred tablets per minute. On account of the plunger descending to the same point every time the lever is swung past the centre, absolute uniformity is obtained in the compression and appearance of the tablets, whether they are required to be hard or soft, and with every movement of the lever a tablet is made and ejected by the machine.

Fig. 147 illustrates a machine designed for making tablets in large quantities. It is power-driven and is capable of turning out from 800 to 1000 tablets per minute.



FIG. 147.—TABLET-MACHINE.

It is important that the dies and punches be perfectly smooth and well polished, if good work is to be turned out; the pressure must be carefully regulated, as if excessive, the tablets disintegrate very slowly or not at all. Insoluble substances should be compressed as lightly as possible.

In tablet-making the three great points to bear in mind are :

- (a) To ensure proper cohesion.
- (b) To prevent adhesion of the tablets to the punches and dies.
- (c) To secure ready disintegration of the finished tablet when immersed in water.

Preparation of the material.—It is not desirable to have the material for compression in a state of fine powder, or it will not feed properly. The condition to be aimed at is that in which ammonium chloride appears—viz., small crystals. Very few substances can, however, be obtained commercially in this condition, and it is better to reduce the material to a state of powder, and granulate it by moistening with dilute alcohol, syrup, mucilage, or water, according to its nature, and press the mass through a sieve. A No. 30 sieve will

be found fine enough for most purposes, but a few substances, like charcoal, pepsin, etc., should be passed first through a No. 20 sieve, and again when dry through a No. 50. When moistening the powder, care should be taken to add only small portions of the liquid at a time, to avoid the formation of a pasty mass. To prevent the granulated powder sticking to the dies, a lubricant of some kind must be added. French chalk in very fine powder, and a 2-per-cent. solution of liquid paraffin in ether, are the most useful. The former should be dusted on to the dry granules, and the whole rotated gently in a wide-mouthed bottle; if ethereal solution of liquid paraffin is used, it may be sprayed over the granules with an atomiser. In either case very small quantities suffice if properly applied. When insoluble substances, such as bismuth subnitrate, sulphonal, etc., are being compressed, the French chalk must be mixed with powdered arrow-root so as to ensure disintegration.

The following formulæ are given as examples of procedure.

Sodium bicarbonate five grains. Take of—

Sodium Bicarbonate	16 ounces
Mucilage of Acacia	$\frac{1}{2}$ ounce
Distilled Water	a sufficiency

Place the sodium bicarbonate in a perfectly clean mortar, add the mucilage, and mix intimately; if necessary add a few drops of water until fairly moistened, but by no means pasty. Now turn out on to a clean sieve having thirty wires to the linear inch, and press through with bottom of a gallipot; dry in a shallow dish by gentle heat, and add a very small pinch of finely powdered French chalk. Mix gently in a wide-mouthed bottle as directed. Stamp into five-grain tablets in the usual manner.

Soda-mint tablets. Take of—

Sodium Bicarbonate	15 ounces
Mucilage of Acacia	$\frac{1}{2}$ ounce

Granulate as above, dry, and add the following mixture:

Ammonium Carbonate	1 ounce
Oil of Peppermint	$\frac{1}{4}$ "
French Chalk	30 grains

Mix by shaking in a bottle. Stamp into five-grain tablets.

Pepsin tablets. Take of—

Powdered Pepsin	8 ounces
„ Sugar	$\frac{1}{2}$ ounce

Moisten cautiously with dilute alcohol; granulate, and dry at a temperature not exceeding 35° C. Lubricate with French chalk. The granulated pepsin should be passed through a No. 50 sieve.

Ammonium chloride. This may be pressed into tablets without any preparation.

Voice tablets. Take of—

Cocaine Hydrochloride	20 grains
Distilled Water.	$\frac{1}{2}$ ounce
Mucilage of Acacia	$\frac{1}{4}$ „

Dissolve, and add to—

Powdered Potassium Chlorate	2400 grains
„ Borax	1600 „

Mix thoroughly; granulate, dry. Stamp into five-grain tablets. Each tablet contains one-fortieth grain of cocaine hydrochloride, three grains of potassium chlorate, and two grains of borax.

Salol. Take of—

Powdered Salol	8 ounces
„ Sugar	$\frac{1}{4}$ ounce

Moisten with alcohol, mix thoroughly, and dry at a temperature not exceeding 40° C. (salol melts at about 42° C.); again pass through sieve, lubricate, and dust with arrowroot. Stamp into five-grain tablets, using as little pressure as will make the salol firmly coherent.

Phenacetin, sulphonal, trional, acetanilide, Dover's powder, bismuth carbonate, etc., tablets may be prepared in the same way as salol.

Saccharin, citrate of lithia, antipyrin, and other freely soluble drugs simply require moistening and granulating. They should all be lubricated with the solution of paraffin in ether. Potassium bromide and iodide merely need crushing; they may then be stamped like ammonium chloride.

Hypodermic tablets should be made up to the required bulk with pure sodium chloride.

Tablet-making is an art which requires considerable experience as to the selection of the moistening agent, as well as to the amount of pressure required.

TABLET TRITURATES

This name is applied to small friable tablets composed of medicated milk-sugar. The mould (fig. 148) may be of vulcanite, and consists of two parts: an upper plate perforated with holes—generally fifty—the size of the tablet required; and a second plate carrying a number of smooth upright pegs, exactly corresponding with the holes in the upper plate, and used to displace the finished tablets.

The first operation is to ascertain the exact capacity of each hole. This is done by moistening finely powdered milk-sugar with proof spirit, and pressing the pasty mass into the holes. The tablets are at once forced out by means of the pegs, dried, and weighed. As a

rule each tablet will be found to weigh about one and one-third grains, but the total weight must be carefully noted. Suppose the total weight to be sixty-five grains; if fifty tablets, each containing one-tenth grain of cocaine hydrochloride, are required, it is only necessary

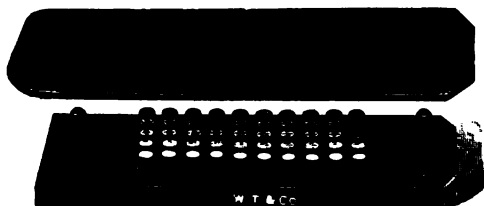


FIG. 148.—TABLET-TRITURATE MOULD.

to triturate six grains of the salt with seventy-two grains of finely powdered milk-sugar, moistening slightly with proof spirit and pressing into the moulds. The excess should weigh exactly thirteen grains if it is collected and dried.

If the active ingredient is a liquid, it must be intimately mixed with the requisite quantity of milk-sugar and evaporated to dryness. Extracts should, according to their nature, be dissolved in the smallest possible quantity of water or spirit, and distributed through the milk-sugar as described for liquids. It is important that the milk-sugar be in the finest possible powder, or the tablets will be too friable to keep their shape when dry. The most generally useful excipient is 40 or 50 per cent. alcohol, but the selection is governed by the nature of the medicament, the rule being to use one possessing only a slight solvent action.

In practice it is found advantageous to lubricate the tops of the pegs by spraying them with a solution of one part of Paraffinum Liquidum in 100 parts of ether. The tablets should be pressed from the mould soon after making, as if left too long they cannot be detached without crumbling.

CHAPTER XXVIII

LOZENGES

In heraldry, a lozenge is a four-sided figure having two acute and two obtuse angles (a rhombus), and it is probable that medicinal lozenges were originally diamond shaped. The term is now extended to round, oval, or other conveniently shaped flattened masses, consisting of a medicinal substance mixed with gum, sugar, extract of currants, etc., and intended for slow solution in the mouth.

Lozenges, or troches (*trochos*, a pill), afford a convenient method of administering many remedies of a mild type, especially such as are intended for continuous application to the throat, as potassium chlorate and tannin, but they are not well adapted for the exhibition of potent remedies.

The Pharmacopœia gives several formulæ for the preparation of lozenges, which yield excellent results. The operation may be divided into three parts—the preparation of the mass, the cutting or dividing into lozenges, and the drying.

In preparing the mass, the active medicinal ingredients are first intimately triturated with a small portion of the sugar. After thorough admixture the gum and remainder of the sugar are added and passed through a sixty-hole sieve. The massing ingredients are

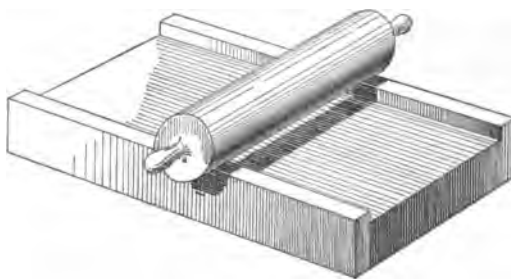


FIG. 149.—LOZENGE-BOARD AND ROLLER.

next added, and the whole thoroughly kneaded in a stone mortar or machine. The mass need not be made so hard or adhesive as a pill-mass, but at the same time must not be so soft that the lozenges fall and lose their shape before they are dry. After mixing, the mass is rolled out on a lozenge-board (fig. 149), the thickness of the cake

being regulated by the height of the bearings at either side of the board. Instead of regulating the thickness of the lozenges by side bearings, the roller itself may be provided with broad flanges, several pairs of which may be stocked for the production of lozenges of different degrees of thickness. If much work is anticipated, the roller should be made of nickelled brass, as wooden rollers soon become indented and cracked. To prevent the mass from sticking, a mixture of two parts of starch with one of sugar is dusted from a dredger over the board. After rolling into a perfectly flat and even cake the mass is divided into lozenges by cutters or punches of any desired shape, the most usual being ovals or circles. For hand-work the cutter consists of a short steel cylinder, fig. 150, A, about a quarter of an inch long, brazed on to a conical body, B. After cutting, the lozenges are placed on shallow trays and left to dry. The temperature of the drying-room should not be higher than 40° C. When required, lozenges are stamped with the name and dose of the principal ingredient.

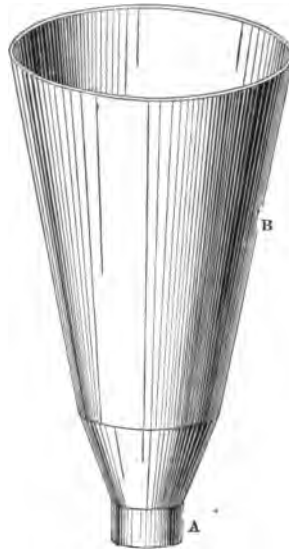


FIG. 150.
HAND LOZENGE-CUTTER.



FIG. 151.—LOZENGE-CUTTING MACHINE.

Fig. 151 shows a lozenge-cutting machine. The mass, having been previously rolled to the desired thickness, is placed on the table, across which an endless rubber belt is made to travel. When the machine is set in motion, the mass is carried under a roller, where it

acquires a finish, before passing over the cutters (ten in number) which are driven upwards through the stripping plate. The cutters being tapered, the lozenges drop into a tray underneath.

The cutter-bar is removable, and any number may be kept in stock, carrying varying shapes and sizes of cutters. The output with ten cutters on a bar is about 500 lozenges per minute.

Pastilles.—Of late years pastilles prepared with a basis of glyco-gelatin have come into very general use, and this is not to be wondered at considering the ease with which twelve or twenty-four pastilles can be turned out for the filling of any special prescription. The most generally useful basis is made as follows :

Gelatin	12 ounces
Glycerin	24 „
Distilled Water	30 „
Oil of Orange-peel	10 minims

Allow the gelatin to soak in the water until softened ; dissolve by the aid of a water-bath ; add the glycerin, and when nearly cool, the oil of orange-peel. Pour out into a flat mould, and when quite cold divide into one-inch squares for convenience in weighing.

Supposing twenty-four pastilles are required, each containing one-eighth grain of cocaine hydrochloride : three grains of the salt is dissolved in 792 grains of warm glyco-gelatin basis, and the mixture



FIG. 152.—BILSON'S PASTILLE-MOULD.

poured into a mould similar to fig. 152. This was designed by Bilson, and is one of the most useful of the kind for small quantities. If the tray is set in a cool place, solidification occurs in a few minutes, when, if the moulds have been *slightly* oiled, the pastilles may be turned out smooth and bright, and ready for sending out.



FIG. 153.—JUJUBE-CUTTING MACHINE.

Jujubes.—Jujubes are often looked upon as sweetmeats, but occasionally are used for the exhibition of certain remedies of very mild type, as eucalyptus oil, etc. Thirty parts of gum arabic, twenty of white sugar, and thirty-five of water are boiled together for half an hour or more in a steam-

jacketed pan, until an even mixture results. After standing a little time the scum is removed, the medicament or flavouring agent

added, and the whole poured into moulds to set. If not sufficiently hard the trays containing the jujube paste are placed in a drying-room for a few days to evaporate. As soon as they are hard enough the sheets are divided by a machine similar to fig. 153, fitted with 'clearers,' which revolve with the blades and prevent the jujubes from sticking. To cut diamond-shape, the strips which have already been put through once are passed through the second time in a diagonal direction, when the jujubes come out as shown in the cut.

Tabella Trinitrini.—This is the only lozenge in the Pharmacopœia for which no actual formula is given; the following gives good results. The 10-per-cent. solution of nitroglycerin should be kept in a safe place, away from the official solution of nitroglycerin, *than which it is ten times stronger*. Take of—

	All by weight
Solution of Nitroglycerin in Alcohol (10 per cent. by weight)	100
Powdered Chocolate	1450
„ Sugar	2500
Mucilage of Acacia	390
Powdered Acacia	360
Distilled Water	200

Mix the powders, add the solution of nitroglycerin, and stir *lightly* until evenly mixed. Add the mucilage and water, and work up to a soft mass; roll into an even cake, and divide into lozenges weighing exactly five grains. Each lozenge will contain one-hundredth grain of nitroglycerin.

NOTE.—Keep the mass soft and plastic, and carefully avoid pounding or concussion during the operation. Finally dry at the ordinary temperature.

CHAPTER XXIX

EYE-DISCS

Preparation of the basis.—Take of

Transparent Gelatin.	180 grains
Glycerin	20 grains
Distilled Water	2 ounces

Mix the glycerin and water; allow the gelatin to soak in the mixture until softened, then dissolve by gentle heat and strain through muslin.

Lamellæ Atropinæ.—Each disc contains one five-thousandth grain of atropine sulphate. Take of—

Basis	80 grains
Solution of Atropine Sulphate (1 grain in 100 minims)	20 minims

Melt the basis by application of gentle heat, and mix. Spread a very thin coating of white beeswax (hard paraffin will not answer) over a piece of plate glass about five inches square. Then take a piece of thick writing-paper and cut out a shape as for a plaster, four inches square, and paste evenly over the waxed glass. Next place the glass on a level slab of iron heated to about 38° C., and when the glass has attained the same temperature pour on the medicated basis and spread it evenly over the surface, taking care that none runs over the edge of the paper shape. As soon as the film has solidified, place the coated glass in a cardboard box to keep out dust, and dry at a temperature not exceeding 36° C. for fourteen days, when the film should be easily detached from the glass. With a punch similar to that used by shoemakers to punch eyelet holes, cut out discs of exactly one-seventh inch diameter.

Calculation for above.—A film four inches square (sixteen square inches in area) would yield 784 square discs, the sides of each square being one-seventh inch, therefore it would equally yield 784 circular discs of one-seventh inch diameter; but as by the latter method of cutting there

would be considerable loss of scrap, it is necessary to use sufficient medicament for 998 (practically 1000) discs. Thus—

The film = 16 square inches

Each disc has an area $\frac{1}{8} \times \frac{1}{8}$ square inch¹

Therefore 784 discs would = 12 $\frac{1}{2}$ square inches

and allowance for the 3 $\frac{1}{2}$ square inches of film wasted, which is equal to 214 discs = in all 998 (practically 1000) discs.

Then, as practically 1000 discs are required, each containing $\frac{1}{5000}$ grain of atropine sulphate, $\frac{1}{5000} \times 1000 = \frac{1}{5}$ grain, or 20 minims of a solution 1 grain in 100 minims, is needed.

NOTE.—For other discs, or discs of other strength, calculate that sixteen square inches of film (i.e., four inches square) requires enough medicament for 1000 discs, although only 784 may be cut from it.

Lamellæ Cocainæ.—Each disc contains one-fiftieth grain of cocaine hydrochloride. Take of—

Basis	180 grains
Cocaine Hydrochloride	20 „

Melt basis, mix, and spread a film having an area of sixteen square inches; when dry divide into circles having a diameter of one-seventh inch.

Lamellæ Homatropinæ.—Each disc contains one-hundredth grain of homatropine hydrobromide. Take of—

Basis	180 grains
Homatropine Hydrobromide	10 „

Melt basis, mix, and spread a film having an area of sixteen square inches; when dry divide into discs each having a diameter of one-seventh inch. Each weighs about one twenty-fifth grain.

Lamellæ Physostigminæ.—Each disc contains one-thousandth grain of physostigmine sulphate. Take of—

Basis	80 grains
Solution of Physostigmine Sulphate	
(5 grains in 100 minims)	20 minims

Melt basis, mix, and spread a film having an area of sixteen square inches; when dry divide into discs each having a diameter of one-seventh inch.

¹ To find the area of a circle multiply the square of the radius by $\frac{22}{7}$.

CHAPTER XXX

POWDERS

The Pharmacopœia recognises sixteen compound powders. The ingredients for these should be passed through a sieve having not fewer than eighty wires in a linear inch. The reduction of medicinal substances to powder is fully dealt with under the head of Comminution, and need not be further considered.

It is important that *all* compound powders should be thoroughly mixed, but those containing potent remedies cannot have too much care bestowed on their admixture. Small quantities may be triturated in an ordinary Wedgwood mortar, uniformity being ensured by passing the product twice through a sieve. In all cases, active ingredients and colouring principles should be first triturated with a small quantity of the diluent, the remainder being added by degrees. To obtain the full power of any colouring material, the powder is usually damped with alcohol or water. The effect of this is well seen if five grains of carmine is mixed with one ounce of dry chalk, and a corresponding quantity after moistening with a little alcohol. In the first instance the colour is scarcely appreciable, while the latter develops a beautiful rose tint.

When the powder contains incompatible substances, as an alkaline carbonate with an acid (effervescing salines, for example), the materials should be dried separately in a hot-air oven, and afterwards mixed lightly and sifted. As pointed out in the section on Explosive Combinations, powders containing potassium chlorate with hypophosphites, tannic acid, sugar, sulphur, etc., must never be rubbed together. If necessity actually requires the dispensing of these chemically incompatible substances, they should be powdered separately, and afterwards mixed very lightly with a horn spatula, and be sifted through muslin stretched on a wooden hoop.

When quantities of more than a few pounds have to be mixed and sifted, it is better to employ one of the numerous combined sifting and mixing machines. Much labour and time are saved, besides avoiding dust and waste. Fig. 154 illustrates a convenient apparatus for retail pharmacists; from one to ten pounds can be mixed and sifted in a few minutes. The construction and application of the machine will be readily understood from the illustration. The lower compartment receives the mixed and sifted powder; the upper consists of a metal box containing a curved sieve. The powder is placed in

this box, the lid closed, and the handle which actuates the scraper moved up and down. The scraper consists of several pieces of stout wire, so arranged that they traverse the arc of the sieve.

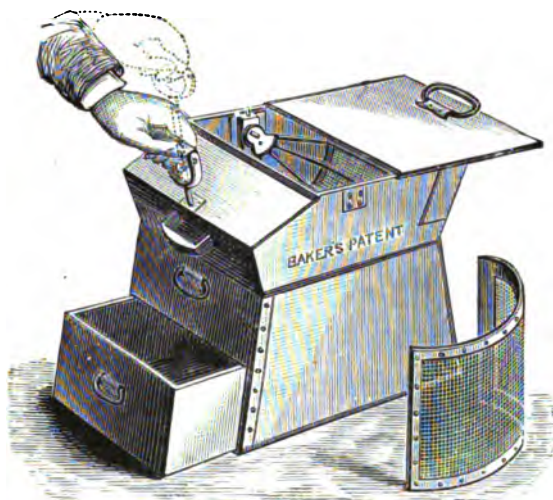


FIG. 154.—MIXING AND SIFTING MACHINE.

When considerable quantities of powders have to be intimately mixed and sifted, a machine similar to fig. 155 is employed. The feed-hopper, A, contains a regulating gate; this can be closed or opened as desired, controlling the supply of ingredients which pass to the sieve, C,

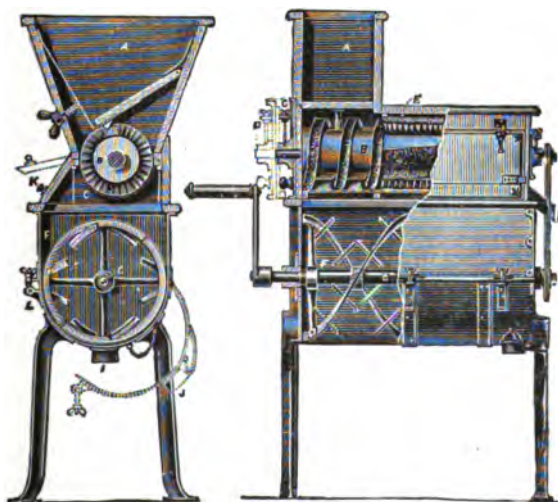


FIG. 155.—MIXING AND SIFTING MACHINE.

where they are acted upon by the spiral brush, B. The first portion of the brush causes the fine powder to pass through the meshes of the sieve, while the lumpy portions are carried along to the reducing portion of the brush.

CHAPTER XXXI

THE PHARMACOPŒIAL PILL-MASSSES

Of the above only two are of sufficient interest to require any comment, the others being simple admixtures.

Pilula Ferri.—This mass has for long been associated with the name of *Blaud*, and his exact formula has been the subject of much discussion. A consideration of the official details shows that the pill is intended to contain about 20 per cent. of ferrous carbonate, but even when freshly prepared there is difficulty in attaining this standard, while on keeping they oxidise rapidly. An experimental batch of pills, when first made, contained 19·14 per cent. of ferrous iron, and 1·27 per cent. of ferric iron, both reckoned as FeCO_3 . At the end of twelve weeks, analysis showed only 10·99 per cent. FeCO_3 , or a deficiency of about 44 per cent. The same pills, kept for one year, showed a deficiency of over 60 per cent. of ferrous carbonate.

From the above it is evident that the official excipients exercise but little protective power on the ferrous salt; and after a lengthy series of experiments the following was found to yield practically theoretical results :

Glucose	150 grains
Distilled Water	30 minims
<i>Dried Sulphate of Iron</i> , in fine powder .	150 grains

Mix and add—

<i>Dried Sodium Carbonate</i> in fine powder	95 grains
--	-----------

Mix and set aside for ten minutes or until reaction is complete. Add—

Powdered Tragacanth	15 grains
Powdered Acacia	50 „

Mass.

Pills made with this mass contain nearly 20 per cent. of ferrous and only a trace of ferric carbonate. The latter salt after keeping is reduced to the ferrous state, so that instead of deteriorating the pills actually improve. Experiments have shown that pills rolled from this mass and coated with gelatin are practically unaltered after the lapse of four years.

Test.—The $\text{K}_2\text{Cr}_2\text{O}_7$ solution used in a determination was of such

strength that 30.5 c.c. was required to oxidise 0.1 gramme of ferrous iron to the ferric state. Two grammes of the pills were placed in a flask with 10 c.c. of dilute phosphoric acid B.P. and 20 c.c. of water, and quickly heated to about 66° C. The mixture was agitated until solution had taken place, and then made up to 100 c.c. Of this 25 c.c. was diluted with 50 c.c. of distilled water, and titrated with the $K_2Cr_2O_7$ solution until the whole of the ferrous iron present was oxidised.

Supposing 1 c.c. of $K_2Cr_2O_7$ solution to have been used :

Then $30.5 : 1 :: 0.1 : x = \frac{0.1}{30.5}$ ferrous iron in 0.5 gramme of pill.

The relative weights of Fe : $FeCO_3 :: 55.6 : 115.15$

\therefore expressed in grammes of $FeCO_3 = \frac{0.1 \times 115.15}{30.5 \times 55.6}$

and as percentage of $FeCO_3 = \frac{0.1 \times 115.15 \times 2 \times 100}{30.5 \times 55.6}$
 $= 1.358$ per cent. $FeCO_3$

So that each c.c. of $K_2Cr_2O_7$ solution used to titrate a solution of 0.5 gramme of pill in 25 c.c. represented 1.358 per cent. of ferrous carbonate.

The ferric iron, expressed in terms of ferric carbonate, was determined as follows :

25 c.c. of pill solution as above was placed in a strong stoppered bottle with 2 c.c. hydrochloric acid and 1 gramme of potassium iodide, and kept at a temperature of 40° C. for half an hour, cooled, and titrated with $\frac{N}{10}$ 'hypo.' solution, starch paste being used as indicator.

Each c.c. of $\frac{N}{10}$ 'hypo.' used = 0.00556 gramme of ferric iron.

The pharmacist, in addition to keeping a stock of the official pills already rolled and rounded, generally finds it necessary to keep stock masses to fill the requirements of special prescriptions in which only small quantities are ordered. Thus, the following prescription contains two pharmacopœial masses, with other ingredients :

R	Pil. Coloc. Co.	.	.	.	.	.	gr. ij.
	Pil. Rhei Co.	.	.	.	.	.	gr. ij.
	Ext. Bellad.	.	.	.	.	.	gr. $\frac{1}{4}$
	Ol. Carui	.	.	.	.	.	mss.

Now if this is dispensed as written, the mass will weigh nearly five grains, and be too soft to roll into pills. If sufficient excipient is added to make them hard enough to retain their shape, then the pills will be inconveniently large. To meet this difficulty it is customary to prepare 'pill powders'; that is, ingredients for pills *minus* the excipients. With a stock of the following 'pill powders' the

dispenser is able to cope with all ordinary prescriptions in which pharmacopœial pill-masses are ordered, without difficulty :

Pulv. pro Pil. Aloës Barb. (1 = 2).—

℞ Pulv. Aloës Barb.	℥ij.
Ol. Carui	℥j.
Misce.	

Pulv. pro Pil. Aloës et Asafetidæ (1 = 2).—

℞ Pulv. Aloës Socot.	℥j.
„ Asafetidæ	℥j.
Misce.	

Pulv. pro Pil. Aloës et Ferri (2 = 3).—

℞ Ferri Sulph. Exsicc.	℥j.
Pulv. Aloës Barb.	℥ij.
„ Cinnam. Co.	℥iij.
Misce.	

Pulv. pro Pil. Aloës et Myrrhæ (2 = 3).—

℞ Pulv. Aloës Socot.	℥ij.
„ Myrrhæ	℥j.
Misce.	

Pulv. pro Pil. Aloës Socot. (1 = 2).—

℞ Pulv. Aloës Socot.	℥ij.
Ol. Myristicæ	℥j.
Misce.	

Pulv. pro Pil. Cambogiæ Co. (1 = 2).—

℞ Pulv. Cambogiæ	℥j.
„ Aloës Barb.	℥j.
„ Cinnam. Co.	℥j.
Misce.	

Pulv. pro Pil. Coloc. Co. (1 = 1).—

℞ Pulv. Colocynth.	℥j.
„ Aloës Barb.	℥ij.
„ Resin. Scammon.	℥ij.
„ Potass. Sulph.	℥ij.
Ol. Caryoph.	℥ij.
Misce.	

Pulv. pro Pil. Galbani Co. (1 = 1).—

℞ Pulv. Asafetidæ	℥ij.
„ Galbani	℥ij.
„ Myrrhæ	℥ij.
„ Sacchari	℥j.
Misce.	

Pulv. pro Pil. Hydrarg. Subchlor. Co. (1 = 1).—

R	Hydrarg. Subchlor.	.	.	.	.	.	3j.
	Antim. Sulphurat.	.	.	.	.	.	3j.
	Pulv. Resin. Guaiaci	.	.	.	.	.	3ij.
	„ Sacch. Lact.	.	.	.	.	.	3ss.

Misce.

Pulv. pro Pil. Plumbi cum Opio (1 = 1).—

R	Pulv. Plumbi Acet.	.	.	.	.	.	5xij.
	„ Opii	.	.	.	.	.	3ij.
	„ Sacch. Lact.	.	.	.	.	.	gr. lxxx.

Misce.

Pulv. pro Pil. Rhei Comp. (5 = 8).—

R	Pulv. Rhei	.	.	.	.	.	3iij.
	„ Aloës Socot.	.	.	.	.	.	3ij. 5ij.
	„ Myrrhæ	.	.	.	.	.	3iss.
	Ol. Menth. Pip.	.	.	.	.	.	3iss.

Misce.

Pulv. pro Pil. Scammonii Co. (1 = 1).—

R	Pulv. Resin. Scammonii	.	.	.	.	.	3j.
	„ Resin. Jalapæ	.	.	.	.	.	3j.
	„ Zingiberis	.	.	.	.	.	3iss.
	„ Saponis Animal.	.	.	.	.	.	3j.

Misce.

Pulv. pro Pil. Scillæ Comp. (2 = 3).—

R	Pulv. Scillæ	.	.	.	.	.	5x.
	„ Zingiberis	.	.	.	.	.	3j.
	„ Ammoniaci	.	.	.	.	.	3j.
	„ Saponis	.	.	.	.	.	3ij.

Misce.

PILL-MAKING BY MACHINERY

The production of pills on a manufacturing scale has entered on an entirely new phase since the first edition of this book was published, and some of the machinery then illustrated is practically obsolete. A detailed description of a modern plant would be somewhat out of place here, but it is felt that a knowledge of the methods now employed may prove of interest.

The illustration (fig. 156) was made from a photograph of the pill-plant of Mr. Kilby Pears, of Hove, and shows the Colton machines, probably the most ingenious of their kind. The ingredients having been massed in a kneading-machine, as fig. 157, the mass is fed into

the hopper A (fig. 156) in the same condition as, or somewhat harder than, a pill-mass made at the dispensing counter. The geared wheels at the base of the hopper are connected with a 'worm' which forces the mass through a conical nozzle on the opposite side of the hopper. By a wonderful piece of adjustable mechanism, as soon as 100, 110, 120 grains, or any desired weight of mass, has passed through, a piece of wire severs it, and it then passes between the endless rubber

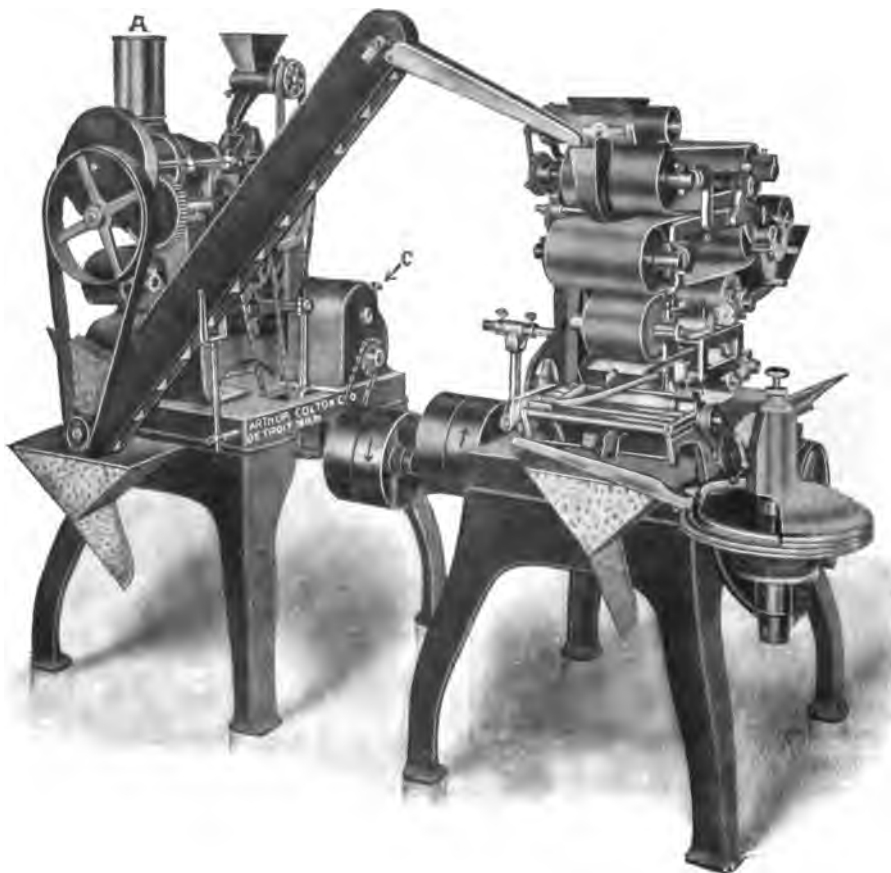


FIG. 156.—MODERN PILL-PLANT.

bands. These bands not only revolve, but possess a side-to-side motion, and the uneven pieces of mass rapidly attain a spherical form.

As the balls leave the bands in rapid succession, they travel up the elevator and drop into the funnel of the machine shown on the right of the illustration. The handle marked c is connected with a variable speed-gear by means of which the delivery can be accelerated or retarded. Each ball, as it leaves the funnel, is engaged by the two upper rubber bands, which, running in opposite directions and at different

speeds, roll it into a perfectly cylindrical pencil or pipe. These pencils fall between revolving cylindrical cutters, and although the pills at this stage of the operation are not very round, the variation in weight does not exceed 0.25 per cent.

So far, massing, piping, and cutting have been dealt with. The imperfectly rounded pills, which fall in a continuous stream, are caught by the two lower pair of rubber bands (also revolving in opposite directions at different speeds, and endowed with a peculiar lateral motion), by means of which they are rendered perfectly spherical. After leaving the bands, the pills run along steel rods, to each of which

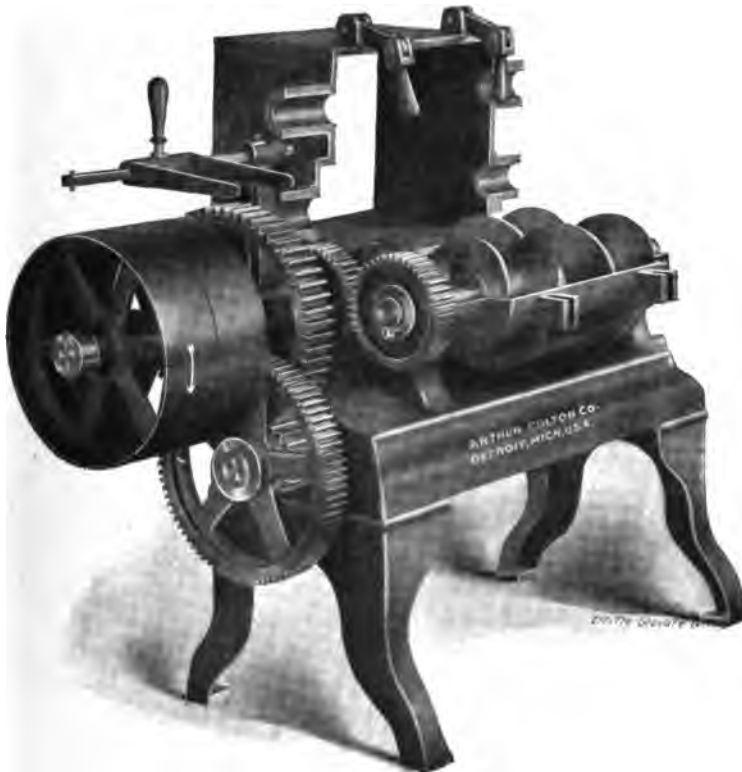


FIG. 157.—MASS-MIXER.

is attached a worm, which automatically rejects all that are a fraction larger or smaller than the standard size.

Such a machine as the above is capable of turning out half a million pills a day, only two operators being required for attendance.

Pearl coating by machinery.—In the pearl-coating department the pills are placed in revolving copper pans (as fig. 158) of various sizes capable of holding from 7 lb. to 1 cwt. Thin mucilage is sprinkled on until the pills are evenly moistened, when they are dusted with finely powdered French chalk. The attrition due to their constantly

rolling over one another produces a perfectly even coat, which is built up by successive increments of mucilage and powder. After the last coat, and when the pills are perfectly dry, it is customary to transfer



FIG. 158.—COPPER PILL-COATING PAN.



FIG. 159.—GALVANISED IRON POLISHING-PAN.

them to another pan (fig. 159) lined with some closely woven material that has been rubbed over with hard paraffin. A few turns of the pan suffice to give a brilliant polish.

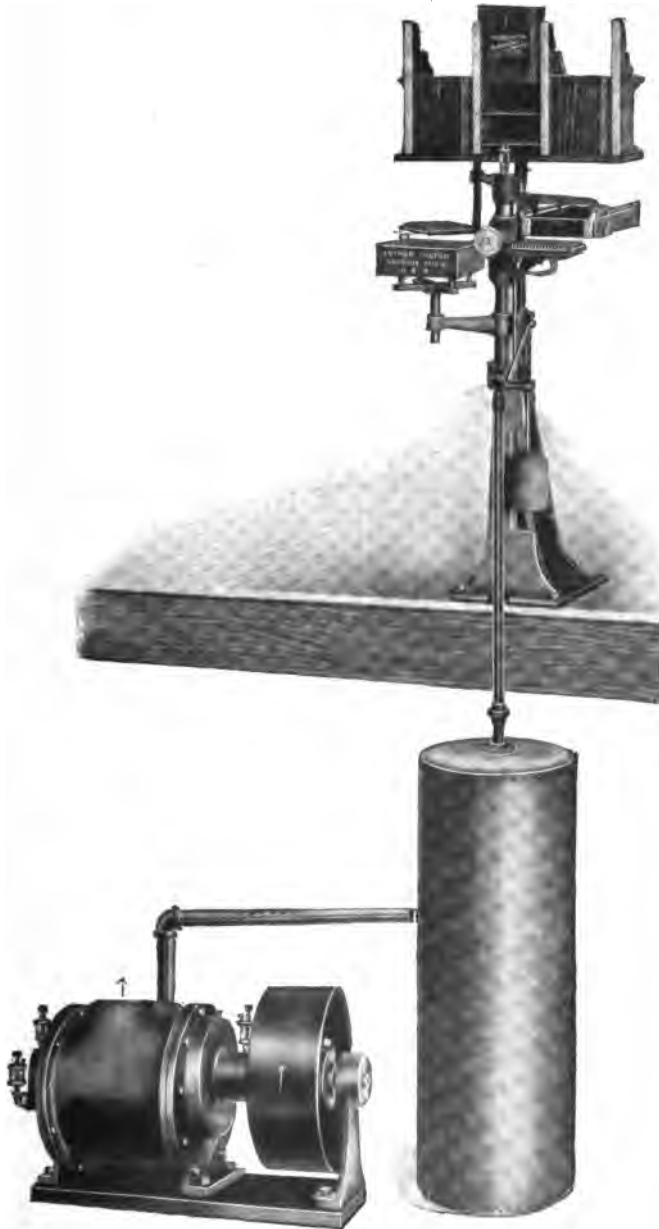


FIG. 160.—GELATIN PILL-COATING PLANT.

The process of pearl coating solely with acacia mucilage and French chalk leaves nothing to be desired, as when placed in

water the pills commence to disintegrate at once. With the older methods a strong varnish was applied before each addition of chalk, consequently the solubility was much impaired. If pharmacists, owing to circumstances beyond their control, are unable to manufacture pearl-coated pills themselves, they can at least apply a simple test for solubility to those they purchase.

Gelatin coating by machinery.—As has been stated earlier, gelatin forms an ideal coating for pills, and now that it is possible to cover them without leaving pin-holes, it is no wonder the process is becoming popular.

The operation is carried out by means of the apparatus shown in fig. 160. Briefly, the pills by means of an ingenious automatic arrangement are picked up by a number of tiny vacuum tubes, and dipped rather more than half-way into hot gelatin solution. The tray carrying the half-dipped pills is then placed in a hot-air chamber, shown at the head of the illustration, and the process continued until the three chambers are filled. By the time the last plate is dipped, the first is ready for the second dipping. A tray of vacuum tubes is now placed so that it picks up the pills on the coated side, and then automatically dips the uncoated half, the two coatings overlapping slightly. This operation is carried on until the drying chambers are again filled—this time with perfectly coated pills.

Sugar coating by machinery.—When the pills are to be sugar coated, they are placed in a pan similar to that shown in fig. 158, but warmed by a steam coil. Pure syrup is sprinkled on as the pills are continually rolled over, and the evaporation of the water leaves a coating of sugar, the process being continued until sufficiently thick. The only drawback to this process is that it cannot very well be employed for smaller quantities than fourteen pounds, while a half-pound or even a quarter-pound of pills can be successfully pearl coated.

CHAPTER XXXII

CONFECTIONS

Confections or electuaries are very ancient forms for the administration of medicines, and are made by simply bringing the solid ingredients to a smooth pasty condition by the addition of syrup, honey, etc.

Confection of pepper is known as Ward's paste. Confection of roses is possibly retained for sentimental reasons. Confection of senna (lenitive electuary) requires great care in manufacture to produce an even product. The ingredients after boiling are first pulped through a twenty-hole sieve to remove the seeds, skins, and fibrous material. While still warm the thin pasty mass is pulped through a sixty-hole sieve, and mixed with the extract of liquorice and twenty ounces of the sugar. By evaporation the whole is then brought to exactly fifty-six ounces by weight, and allowed to cool. When almost cold the powdered senna and coriander, previously mixed with the remainder of the sugar, are sifted in through a sixty-hole sieve and intimately mixed. If the mixed powders are added to the pasty mixture while hot, it will form into little balls, which can only be broken up and evenly distributed by passing the whole of the confection again through a sieve.

The pulping is accomplished by placing a sieve over a wide-mouthed jar or mortar, and forcibly pressing the softer parts of the well-boiled fruits through, by rubbing with the bottom of a gallipot. The operation is somewhat tedious, and cannot be hurried without detriment to the product.

CHAPTER XXXIII

GRANULAR EFFERVESCENT PREPARATIONS

Granular effervescent salts afford a palatable and pleasant form for the administration of many medicinal substances. Although the Pharmacopœia only recognises seven preparations of this class, so many different combinations are in constant demand that the pharmacist should be in a position to manufacture them for himself, particularly as no expensive apparatus is required for their production. Different methods of granulation are employed according to the nature of the medicinal substance, but all require the ingredients in a state of fine powder. Salts containing a large amount of water of crystallisation, as sodium sulphate, must be desiccated, otherwise fusion of the mixed salts will result in loss of carbon dioxide. A good general working basis may contain approximately—

Tartaric Acid	28 per cent.
Citric Acid	19 "
Sodium Bicarbonate	53 "

The general rule when experimenting with new formulæ is to calculate for drachm doses, and to add sufficient basis to each dose of the medicament to bring the total weight up to seventy grains. The loss in granulation is from 10 to 15 per cent. of the weight of basis operated on. If, for example, granular effervescent citrate of caffeine, two grains in a drachm, is required, sixty-eight grains of basis should be mixed with two grains of caffeine citrate. The basis must be freshly mixed for each operation.

General Directions.—Mix the powders intimately; place on a tin-lined or enamelled tray, heated to about 100° C., and when the particles commence to aggregate, move them about, turning the whole over occasionally by means of a broad spatula, until a granular lumpy mass is formed. Remove from the source of heat, break up the large pieces, and pass through a sieve of suitable mesh. Afterwards dry the granules and preserve in well-sealed bottles.

Substances likely to be injured by heat, such as pepsin, etc., should be granulated in the cold. This can be accomplished by mixing the acids and sodium bicarbonate in a mortar, using sufficient pressure to cause the powders to become somewhat pasty. The medicament

is next incorporated, and the mixture left until sufficiently soft to be pressed through a No. 6 or No. 8 wire sieve, when it is dried at a low temperature. If dried in a mass it requires to be broken up in a mortar, the fine powder being sifted from the granules by a fifteen- or twenty-hole sieve. It is important that the sieves used in granulating operations be thoroughly well tinned.

Alcohol, acetone, etc., have been suggested for moistening the dry powders before granulating, but their use is not particularly to be recommended.

The following examples may be found useful :

Granular Effervescent Salicylic Acid (5 gr. in 1 dr.).—

Salicylic Acid (physiologically pure)	. 600 gr.
Sodium Bicarbonate	8½ oz.
Tartaric Acid	3 „
Citric Acid	3 „

Granular Effervescent Ammonium Bromide (10 gr. in 1 dr.).—

Ammonium Bromide	3 oz.
Sodium Bicarbonate	8½ „
Tartaric Acid	4 „
Citric Acid	3 „

Granular Effervescent Bismuth Citrate and Pepsin.—

Bismuth Ammonio-Citrate	1¼ oz.
Pepsin	½ „
Sodium Bicarbonate	8½ „
Tartaric Acid	4 „
Citric Acid	3 „

Granular Effervescent Lithium Salicylate (5 gr. in 1 dr.).—

Lithium Salicylate	320 gr.
Sodium Bicarbonate	4½ oz.
Tartaric Acid	2¼ „
Citric Acid	1¼ „

Granular Effervescent Potassium Bromide (10 gr. in 1 dr.).—

Potassium Bromide	2½ oz.
Sodium Bicarbonate	8 „
Tartaric Acid	4½ „
Citric Acid	2½ „

Granular Effervescent Potassium Citrate (10 gr. in 1 dr.).—

Potassium Bicarbonate	1¼ oz.
Sodium Bicarbonate	5¼ „
Tartaric Acid	1¼ „
Citric Acid	3¼ „

Must be dried in a warm room after granulating.

Granular Effervescent Caffeine Hydrobromide (2 gr. in 1 dr.).—

Caffeine Hydrobromide	120 gr.
Sodium Bicarbonate	4½ oz.
Tartaric Acid	2½ „
Citric Acid	1½ „

Granular Effervescent Antipyrin (5 gr. in 1 dr.).—

Antipyrin	600 gr.
Sodium Bicarbonate	8½ oz.
Tartaric Acid	4 „
Citric Acid	3 „

Granular Effervescent Quinine Salicylate (1 gr. in 1 dr.).—

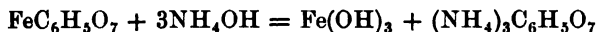
Quinine Salicylate	56 gr.
Sodium Bicarbonate	4½ oz.
Tartaric Acid	2 „
Citric Acid	1½ „

CHAPTER XXXIV

SCALE PREPARATIONS

Of late years a large number of scale compounds containing iron have been introduced into pharmacy, but as they are all prepared on similar lines, it will be sufficient to describe the three official ones.

Ferri et Ammonii Citras.—Ferric hydroxide is first prepared by pouring solution of ferric sulphate into dilute ammonia, and washing the precipitate until free from sulphates.¹ After draining, the ferric hydroxide is squeezed gently and added to strong solution of citric acid until, after warming to about 50° C., no more iron is taken up. This gives solution of ferric citrate. On the addition of ammonia, double decomposition may take place—



Ferric hydroxide, if formed, is not precipitated, but is held in solution by the ammonium citrate, just in the same way as cupric hydrate is kept up by tartarated soda in Fehling's solution. The addition of excess of ammonia does not cause a precipitation of the iron, hence it is assumed that a soluble complex salt—ammonium ferro-citrate—is formed.

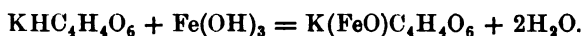
The resulting clear mixture is then concentrated to a syrupy consistence, spread in a thin layer on sheets of glass, and allowed to dry in a warm atmosphere free from dust. In establishments where very large quantities of scale preparations are turned out, the moist air is constantly drawn out of the drying-room by a ventilating fan, air that has been filtered through cotton wool being admitted to take its place.

Incinerated with free access of air iron and ammonium citrate leaves from 31 to 32 per cent. of ferric oxide. It should readily dissolve in half its weight of water. Heated with caustic potash, it evolves ammonia and deposits ferric hydrate; if this is filtered out, the filtrate should not yield a precipitate of potassium acid tartrate, when faintly acidified with acetic acid—*distinction from Ferrum Tartaratum*.

¹ The washing of such precipitates is best accomplished by stirring with a large volume of distilled water, allowing to deposit, and decanting by means of a syphon, the process being repeated three or four times. It is important to add the iron solution to the ammonia, as, if the order is reversed, some oxysulphate is formed which afterwards impairs the transparency of the scales.

Ferri et Quininae Citras.—In the first stage ferric hydroxide is prepared as in the foregoing, and washed free from sulphate. Quinine alkaloid is next precipitated from the sulphate by ammonia, and also washed until free from sulphate. The squeezed ferric hydroxide is then dissolved in solution of citric acid, the quinine added, and solution of ammonia poured in, a little at a time, so that the precipitate of quinine which at first forms re-dissolves. It is then filtered and scaled in the usual way. Incinerated as described under *Ferri et Ammonii Citras* it yields 18 to 20 per cent of ferric oxide. Five grammes dissolved in 45 c.c. of water and treated with slight excess of ammonia in a separator should yield a white precipitate of quinine which may be extracted with ether as described under *Alkaloidal Assay*. The mixed ethereal solutions, when evaporated, should leave a residue, when dried at 120° C., weighing 0.75 gramme, equivalent to 15 per cent. of quinine.

Ferrum Tartaratum.—This compound differs somewhat from the preparations just described. Ferric hydroxide is precipitated and added to hydrogen potassium tartrate and allowed to stand for some time, when probably the following reaction takes place :



The mixture is then warmed, filtered, and the filtered solution concentrated and scaled as previously described.

When boiled with caustic potash, the ferric hydrate removed by filtration, and the filtrate slightly acidified with acetic acid, a precipitate of acid potassium tartrate forms—*distinction from Ferri et Ammonii Citras*. Tartarated iron is freely but very slowly soluble in water. After incineration and subsequent washing (to remove the potassium carbonate) the salt yields about 30 per cent. of ferric oxide.

CHAPTER XXXV

PREPARATIONS FROM ANIMAL PRODUCTS

Fel Bovinum Purificatum.—See Extracts, page 136.

Pancreatinum. (See also *Liquor Pancreatis*.)—Pancreatin is a mixture of ferments or enzymes obtained from the pancreas or sweetbread—generally of pigs. The pancreatic juice has an alkaline reaction, and possesses the property of converting starch into sugar, digesting albuminoids, and emulsifying fats.

Pancreatin may be obtained by macerating finely chopped sweetbreads in water slightly acidulated with hydrochloric acid, for two days. The strained liquor is then neutralised with calcium carbonate, filtered, and mixed with strong alcohol. The precipitated pancreatin is collected, washed, and spread in a thin layer on sheets of glass to dry. Unlike pepsin, it is not precipitated by saturated solution of sodium chloride. The United States Pharmacopœia determines its value as follows: 0.28 gramme of pancreatin, and 1.5 grammes of sodium bicarbonate are dissolved in 100 c.c. of water heated to 38° C., and mixed with 400 c.c. of fresh cow's milk, also heated to 38° C. If the mixture is maintained at the same temperature for thirty minutes, no coagulation should occur when strong nitric acid is added to a small quantity contained in a test-tube.

Pepsinum.—Pepsin is a proteolytic ferment obtained from the mucous lining of fresh stomachs from healthy pigs. When tested by the pharmacopœial process it should be capable of dissolving 2500 times its own weight of freshly coagulated and disintegrated egg-albumen.

Pepsin may be prepared by the following process. Perfectly fresh pigs' stomachs are slit open and freed from adhering food. The stomachs are next scraped, and the pulp macerated in water acidulated with hydrochloric acid for several days, with frequent stirring. The mixture is then strained and allowed to deposit. After decanting, the clear liquid is mixed with sodium chloride, which causes the pepsin to float to the surface. After complete separation has taken place, the pepsin is collected and pressed to remove saline matter. Purification is effected by redissolving in distilled water, again precipitating with salt, collecting, and pressing; the last traces of salt

being got rid of by washing with a little distilled water. The moist pepsin is then dried as rapidly as possible at a low temperature *in vacuo*. This yields powdered pepsin; if required in scales, a strong solution containing a little dextrin is spread in thin layers on glass plates and dried in a warm chamber free from dust.

Dry pepsin is scarcely affected by a temperature of 100° C., but in solution if heated to this temperature it rapidly loses its proteolytic power. *Glycerinum Pepsini* should contain five grains of the official pepsin in each fluid drachm. *Vinum Pepsini* is usually made by dissolving 160 grains of pepsin in a pint of sherry, and filtering bright by the aid of kieselguhr. As thus made, it is very prone to deposit. The author prefers to use fresh pepsin *that has not been dried*, dissolved in the smallest quantity of glycerin slightly acidulated with hydrochloric acid.

Testing of Pepsin.—The official requirements are that pepsin shall dissolve 2500 times its weight of freshly coagulated white of egg in six hours at a temperature of 41° C. There are two sources of error, however, in applying the official test. In the first place, coagulated white of egg does not appear in the fine shreds assumed, but aggregates into more or less compact masses. These present but little surface to the pepsin, and they cannot be separated even by the most vigorous shaking. In the second, it is not practicable to weigh so small an amount as 0.005 gramme of a hygroscopic substance like pepsin. The author therefore suggests the following modification:

Into a stoppered 250-c.c. flask introduce 20 c.c. of the 'pepsin solution.' Place 12.5 grammes of the freshly coagulated albumen (prepared as directed by the B.P.) in a small mortar with 50 c.c. of 0.2 per cent. hydrochloric acid, and triturate until reduced to uniform granules. Transfer to the flask, washing out the last traces of albumen with another 50 c.c. of the dilute acid. Immerse the flask in a water-bath, so that the water is higher on the outside than the mixture inside, and digest at a temperature of 41° C. for six hours, shaking vigorously at intervals of half an hour.

To make the 'pepsin solution' triturate 0.25 gramme of pepsin and 1 gramme of sodium chloride in a small mortar until evenly mixed; add 0.2 per cent. hydrochloric acid very carefully at first, mix well, and transfer to a litre flask; wash the mortar well with more of the dilute acid to make up to the litre mark on the neck. Preserve for twenty-four hours, shaking at intervals and immediately before use. Twenty c.c. of this contains 0.005 gramme of pepsin.

The white of egg is prepared by boiling fresh eggs for fifteen minutes, immersing them in cold water until they can be handled, separating the coagulated 'white,' and immediately rubbing it through a sieve having twelve meshes to a centimetre. The product must be used at once before it loses moisture.

Gelatinum.—All animals contain certain tissues which by continued boiling with water dissolve, the solution on evaporation to dryness yielding a brittle substance, which in a pure state is transparent and free from smell. This substance is called gelatin; it swells up in cold water, and on heating dissolves, the solution if not too dilute (1 in 50), setting to a jelly on cooling. Among gelatin-yielding substances are osseine (the organic matter of bones), tendons, cartilage, etc. Gelatin does not pre-exist in the tissues, but is formed by the action of the boiling water on the so-called 'collogens.'

Briefly, the process of making gelatin consists in boiling these materials with water until they dissolve. The solution is then drawn off, strained, and allowed to cool, the jelly being afterwards cut into strips and placed on netting to dry. It is important to note that gelatin solution, after it has been alternately heated and cooled several times, finally refuses to set.

Thyroideum Siccum.—Thyroid powder is obtained by mincing the perfectly healthy glands, and drying at a temperature not exceeding 40° C., powdering the dry product, removing fat by percolation with petroleum spirit, and again drying the residue. As long as the powder is kept perfectly dry it does not deteriorate, but if allowed to become damp, putrefaction sets in. See also *Liquor Thyroidei*.

Keratinum.—See Pill-coating.

CHAPTER XXXVI

CAPSULES

Gelatin capsules are now very largely used for the administration of nauseous drugs both in the solid and liquid form. Empty shells of soft gelatin, may be procured from the manufacturers ready for filling, or they may be prepared by dipping slightly oiled olive-shaped moulds (fig. 161), fixed on a frame, into a solution of gelatin, allowing excess to drain off, and rotating slowly until the gelatin sets in an



FIG. 161.
CAPSULE-MOULD.



FIG. 162.—CAPSULE-FILLING.

evenly distributed coat. When cold, a knife is passed round the necks of the moulds, and the shells are gently detached and placed in supports to dry.

When ready for filling the capsules are placed in convenient supports (an ordinary suppository-mould answers very well for small quantities) and the liquid introduced by means of a syringe with a long fine nozzle. If any oily fluid touches the neck of the shell it must be wiped off before attempting to seal, or a leaky capsule will be

the result. There are several methods in use for closing the capsule ; the most convenient is to touch the opening with a camel-hair brush charged with thick gelatin solution.

Experience shows that it is almost impossible to keep the hand perfectly steady when filling capsules, and a device similar to fig. 162 is found useful. A rigid and heavy stand supports the syringe, the capsules being pushed under the nozzle one by one. It is essential that the piston of the syringe should fit the barrel accurately and yet sufficiently easily to move without jerking. The following is a good working formula for the gelatin solution :

Gelatin	16 ounces
Glycerin	12 „
Water	22 „
Syrup	8 „

Hard gelatin capsules (fig. 163) are occasionally used for dispensing powders and pastes. They may be made if desired by dipping cylin-

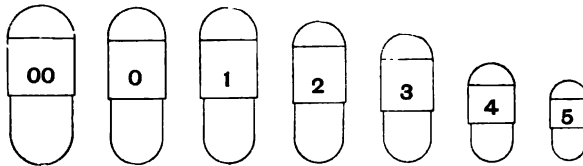


FIG. 163.

drical iron moulds, one mould being slightly larger than the other, into a solution of gelatin made as follows :

Gelatin	6 parts
Gum Acacia	1 part
Sugar	1 „
Water	6 parts

draining, cooling, and detaching as described for *soft* gelatin capsules. The shells are afterwards dried in a current of warm air until perfectly hard. For use, the smaller half is filled with the medicament and the cap slipped over the end. Various devices have been introduced for the expeditious and cleanly filling of these hard capsules. In no case should the capsule be filled by simply pressing into a heap of the powder. With bitter drugs such as quinine, no matter how carefully the capsule is afterwards wiped, the taste will be perceptible as soon as placed in the mouth.

The most convenient method is to place the empty shells in holes sunk in a block of wood, introducing the medicament by means of a small funnel and plunger (fig. 164). With ordinary care it is quite possible to fill the capsules without getting any of the drug on the outside. If desirable the inner edge of the cap can be painted with

a little mucilage before slipping on, and the contents hermetically sealed.

The following short list of the capacity of these capsules may be helpful in selecting the appropriate size :

	Size of Capsule and Weight in Grains						
	00	0	1	2	3	4	5
Bismuth Subnitrate	20	40	10	8	6	4	2
Dover's Powder	12	8	6	4	3	2	1
Powdered Rhubarb	8	6	4	3	2	1½	¾

There are some drugs and compounds the capsuling of which presents a little difficulty.

Creosote and guaiacol.—These are usually prescribed in one and two minim doses, but are always diluted with almond oil to at least five minims.

Fluid extract of cascara.—The ordinary dose in a capsule is thirty minims. If the extract is simply evaporated to a pasty consistence and then filled into soft capsules, the latter soon shrink and become unsightly. To avoid this, a proportionate quantity of the dry extract should be reduced to fine powder and mixed with vaseline or liquid paraffin.

Blaud's pill capsules.—Dry the alkali perfectly and mix with soft white paraffin. Powder the ferrous sulphate, dry at 100° C., and also mix with soft paraffin ; then mix the two together and capsule as rapidly as possible.

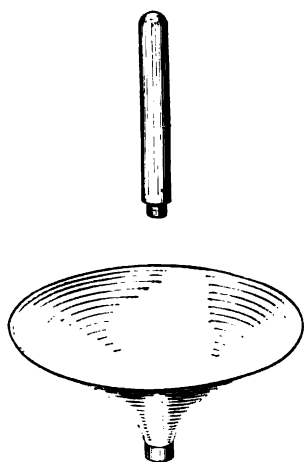


FIG. 164.—CAPSULE-FILLER.

Folding capsules consist of very thin sheets of gelatin, and may be used in a similar manner to wafer papers, for covering nauseous powders and confections. They are especially useful when the dose is too great for an ordinary capsule. The powder is placed in the centre of a sheet, the edges turned over and secured by moistening with water or mucilage. The gelatin sheets may be prepared by pouring a very thin film of gelatin solution (gelatin 25, water 60, glycerin 1) into a shallow tray, allowing it to set, and then detaching and hanging up to dry. The films should be cut into sheets two-and-a-half inches wide and three inches long.

Perles.—This form of capsule can only be prepared on a manufacturing scale, the necessary apparatus being somewhat large and costly. The process consists in spreading a mixture of gelatin, gum,

and sugar, by means of a machine in which the solution is kept warm in a jacketed reservoir (fig. 165); from this it finds its way on to a level slab, which travels in grooves beneath an accurately



FIG. 165.—LEAF-SPREADING MACHINE.

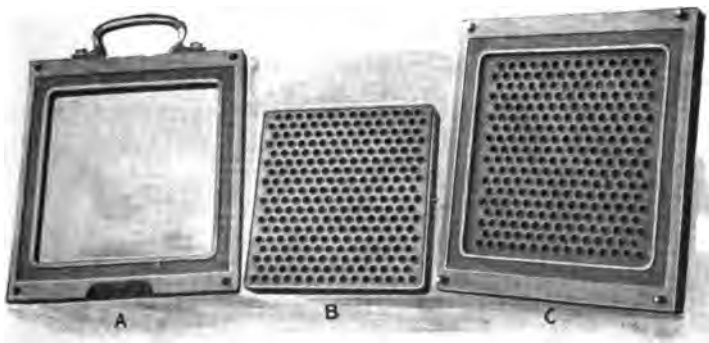


FIG. 166.—PERLE-MOULDS.

adjusted knife-edge, the solution being distributed in a thin film of the required area and thickness. The film, as soon as cold, is detached,

when it is ready for use. One of the films is then laid on a brass mould (fig. 166), with a number of depressions corresponding to the size of perle required, and gently warmed until it accommodates itself to the hollows. The liquid medicament is then poured into the centre of the film, and a second mould, with a film exactly similar to the



FIG. 167.—PERLE-PRESS.

first, is laid over it, and the whole placed in a powerful press (fig. 167), when the liquid, being unable to escape, forces the gelatin into the depressions, which are instantly filled. At the same time the perles are sealed and separated by the projecting edges. After removal from the press the perles are washed with alcohol or other solvent to remove any traces of adhering medicament, and left to dry.

CHAPTER XXXVII

MEDICATED COTTONS AND GAUZES

Medicated dressings are prepared by impregnating absorbent material with solution of a drug and afterwards drying. When the medicinal substance is freely soluble in water, a solution of definite strength is prepared, and the material allowed to soak in it until thoroughly saturated. It is then withdrawn from the solution and squeezed until only sufficient liquid is retained to correspond with a definite percentage of the active ingredient. The wet material is then laid on nets, and turned over from time to time to ensure even distribution of the liquid during the drying. Examples of this method of procedure are boric acid and sal alembroth cottons. When the active ingredient is poisonous, as mercuric chloride, it is customary to colour the solution with aniline blue.

For the medication of cottons, etc., with iodoform, iodol, etc., solutions are prepared in a mixture of alcohol and ether. The solutions are poured into the centre of the material, which is then quickly rolled up into a ball and submitted to hydraulic pressure for a few moments. It is then taken out of the press, shaken slightly, rolled up, and again pressed. By this means a small quantity of liquid can be made to damp a comparatively large bulk of absorbent material.

The following examples will show the different methods employed.

Cotton with sal alembroth.—Contains 1 per cent. of mercuric chloride.

Sal Alembroth	2·4 parts by weight
Soluble Water Blue	0·05 " "
Distilled Water	150·0 " "
Absorbent Cotton	100·0 " "

Dissolve; soak the cotton in the solution until evenly wetted, and squeeze until it weighs 225 parts; dry. This is commonly known as 'blue wool.'

Cotton with boric acid 10 per cent.—

Boric Acid	12 parts by weight
Boiling Water	138 " "
Absorbent Cotton	90 " "

Dissolve; soak the cotton in the solution, and squeeze until it weighs 215 parts; dry.

Cotton with iodoform 10 per cent.—

Iodoform	10 parts by weight
Methylated Ether, sp. gr. 0·717 ..	70 " "
Absorbent Cotton	90 " "

Distribute the solution evenly through the cotton, press quickly, and spread out to dry, away from naked lights or fires, and in a dark place.

Medicated Gauzes

The gauze employed should be of soft texture, and contain about sixty threads to the linear inch; it requires purification by some process similar to the following: 100 parts of gauze is soaked for several hours in warm water, then wrung out and boiled for several hours in water containing soap and common washing soda. The gauze is then well washed in clean water and soaked for several hours in dilute chlorinated lime solution; again washed, soaked in dilute hydrochloric acid, and washed in running water until every trace of chlorine or acid is removed; it is then dried.

To medicate the gauze, either an atomiser is used to spray the solution upon it, or the gauze is immersed in the solution and then dried.

Carbolic gauze, 10 per cent.—

Castor Oil	5 parts by weight
Resin	48 " "
Phenol	12 " "
90-per-cent. Alcohol	85 " "

Dissolve; in the solution impregnate 90 parts of purified gauze, and press until the weight is 215; dry.

Salicylic gauze, 10 per cent.—

Salicylic Acid	12 parts by weight
90-per-cent. Alcohol	68 " "
Distilled Water	70 " "

Dissolve; impregnate 90 parts by weight of purified gauze in the mixture, and press until the weight is 215; dry. If desired a gauze of the same type as carbolic can be prepared, using an equivalent quantity of the oil, resin, and alcoholic mixture in place of the mixture of alcohol and water.

Boric acid gauze, 10 per cent.—

Boric Acid	12 parts by weight
Hot Distilled Water	138 " "
Gauze	90 " "

Press to obtain 215 parts, and dry.

Thymol gauze, 2 per cent.—

Thymol	3 parts by weight
Resin	5 " "
Spermaceti	50 " "
Alcohol (90 per cent.)	50 " "
Gauze	92 " "

Moisten the gauze with the solution, place in a hot press, squeeze two or three times to distribute the medicament evenly, and dry.

Iodised gauze, 10 per cent.—

Purified Gauze	90 parts by weight
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Place in a wide-mouthed stoppered bottle, and heat to 100° C. Then take of—

Iodine	10 parts by weight
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Wrap in blotting-paper, and drop into the jar ; heat until the gauze is uniformly impregnated.

Iodoform gauze, 10 per cent.—

Iodoform	10 parts by weight
Methylated Ether	70 " "
Gauze	90 " "

Dissolve the iodoform in the ether, moisten the gauze, wrap in paper, press quickly, and dry in the dark, away from lights or fires.

PART III

ASSAYING AND TESTING

CHAPTER XXXVIII

ALKALOIDAL ASSAY OF CRUDE DRUGS

Aconite Root

No practical method for the separation of the alkaloids of aconite root is available, but the following modification of Farr and Wright's method, by which the ether-soluble alkaloid is determined, affords probably the best indication of the value of the drug.

Extraction of Drug.—Introduce 10 grammes of aconite root, in No. 40 powder, into a 200-c.c. stoppered flask, add 75 c.c. of 70-per-cent. alcohol, and set aside, shaking at intervals, for twenty-four hours. Transfer the contents to a small percolating tube, and, when droppings cease, add 70-per-cent. alcohol until 150 c.c. of percolate has been collected. Avoid loss by evaporation.

Extraction of the alkaloid as sulphate.—Evaporate the tincture to dryness at a temperature not exceeding 60° C. Add 5 c.c. of $\frac{N}{10}$ H_2SO_4 and 25 c.c. of distilled water, warm, and when the extractive is dissolved, filter into a separator, washing with about 25 c.c. more water.

Extraction as free alkaloid.—Add 25 c.c. of ether and 2 c.c. of solution of ammonia 0.959, and agitate. Draw off the lower layer, and filter the ethereal solution of alkaloid into a small flask. Return the alkaline liquid to the separator, and again extract with 15 c.c. of ether. Agitate, and separate as before. Repeat the extraction with two other portions (10 c.c. each) of ether.

Titration.—Evaporate the combined ether-solutions to dryness, and dissolve the residue in 3 c.c. of $\frac{N}{10}$ H_2SO_4 . Add a few drops of cochineal indicator, and titrate back with $\frac{N}{50}$ KOH.

Each c.c. of $\frac{N}{10}$ H_2SO_4 in combination with alkaloid corresponds to 0.064 gramme of aconitine. Yield from 0.35 to 0.6 per cent.

Belladonna Leaves (U.S.P. method)

Preparation of tincture.—Introduce 10 grammes of leaves, in No. 60 powder, into a stoppered flask, with 10 c.c. of chloroform and 40 c.c. of ether. Shake, and stand for ten minutes. Add 2 c.c. of solution of

ammonia 0.959 and 3 c.c. of water. Shake well at frequent intervals during an hour. Transfer the contents to a small percolating tube connected with a separator, and, when droppings cease, pack tighter by aid of a glass rod and add 50 c.c. of chloroform-ether mixture by degrees.

Extraction of alkaloid as sulphate.—Add to the contents of the separator 6 c.c. of $\frac{N}{1}$ H_2SO_4 and 20 c.c. of water, shake well, separate, and draw off the acid solution. Twice repeat the extraction with 13 c.c. of acid mixture and separate.

Extraction as free alkaloid.—Mix the acid solutions in a separator, make alkaline with ammonia, and shake out with three successive portions (10 c.c. each) of chloroform. Allow the chloroform to evaporate spontaneously.

Titration.—Dissolve the residue in 3 c.c. of ether, and allow this also to evaporate. Add 3 c.c. of $\frac{N}{10}$ H_2SO_4 and titrate back with $\frac{N}{50}$ KOH, using cochineal as indicator.

Each c.c. of $\frac{N}{10}$ H_2SO_4 in combination with alkaloid corresponds to 0.0287 gramme of the total mydriatic alkaloids of belladonna *reckoned as atropine*. Yield averages 0.3 per cent.

Henbane and stramonium may be assayed in a similar manner.

Belladonna Root (Dunstan and Ransome)

Extraction of alkaloids from root.—Take 20 grammes in fine powder, pack in a cartridge, and exhaust by means of Soxhlet apparatus with a mixture of equal parts of absolute alcohol and chloroform.

Preparation of a clean spirituous solution of alkaloid.—Transfer the solution of alkaloids to a separator and agitate with two lots (25 c.c. each) of distilled water. Wash the mixed dilute spirituous solutions of the alkaloids which result with 5 c.c. of chloroform to remove traces of fat.

Extraction of free alkaloid.—Make alkaline with ammonia and extract the liberated alkaloid with two lots (20 c.c. each) of chloroform. Allow to evaporate spontaneously.

Titration.—Add 3 c.c. of $\frac{N}{10}$ H_2SO_4 and 5 c.c. of water. Warm until dissolved, and titrate back with $\frac{N}{50}$ KOH, using freshly-made cochineal as indicator.

Each c.c. of $\frac{N}{10}$ H_2SO_4 in combination with alkaloid corresponds to 0.0287 gramme reckoned as atropine.

Cinchona Bark (official process)

When used for purposes other than obtaining the alkaloids or their salts, cinchona bark should yield between 5 and 6 per cent. of total alkaloids, of which not less than half must consist of quinine and cinchonidine.

Details of assay process.—

Red Cinchona Bark in No. 60 powder	20 grammes
Calcium Hydroxide (fresh)	6 „
Distilled Water	20 c.c.

Triturate very thoroughly in a porcelain mortar and allow to stand for two hours, when it should present the appearance of a moist dark brown powder in which no lumps are visible.

Transfer the powder to a suitable flask fitted with a reflux condenser, and add 130 c.c. of benzolated amylic alcohol. Boil for half an hour, allow to settle, and decant the clear liquid on to a filter, leaving the partially exhausted powder in the flask.

NOTE.—A convenient condenser may be made by fitting the flask with a good cork, through which a glass tube of fairly wide bore and about six feet in length is passed. The large surface exposed to the air is quite sufficient to condense the greater part of the vapour. Another plan consists in placing a good-sized funnel in the flask, and then standing another flask, containing cold water, in the mouth of the funnel.

Add more benzolated amylic alcohol to the powder, boil as before, decant, and filter.

Repeat this operation a third time, then turn the contents of the flask on to a filter, washing out the flask with a little more benzolated amylic alcohol. The washings added to the previous filtrates should amount to about 200 c.c.

Introduce the mixed filtrates, which now contain the whole of the alkaloids, while still warm, into a stoppered glass separator, and add—

Dilute Hydrochloric Acid	2 c.c.
Distilled Water (warm)	12 „

Shake well together, allow the acid liquid to separate, and draw off.

Repeat the operation three times, finally mixing the acid liquids, which will contain the alkaloids as hydrochlorides. While still warm *exactly* neutralise with solution of ammonia, and concentrate to 16 c.c. Cool, and add 1.5 grammes of tartarated soda ($\text{KNaC}_4\text{H}_4\text{O}_6$) dissolved in 3 c.c. of distilled water. Stir well with a glass rod and set aside. At the end of three hours the precipitate, which consists of the mixed tartrates of quinine and cinchonidine, is collected on a filter, washed with distilled water, and dried at

100° C. (The mother-liquor and washings are reserved for further treatment.) These tartrates contain practically eight-tenths of their weight of alkaloid, so that if the total weight is multiplied by eight and divided by ten, it gives the weight of quinine and cinchonidine in 20 grammes of bark, and this weight multiplied by five gives the amount in 100 grammes.

To the mother-liquor from the above, add solution of ammonia in slight excess. Collect, wash, and dry the precipitate, which consists of quinidine and cinchonine with other alkaloids of cinchona. The weight of these multiplied by five, and added to the percentage of quinine and cinchonidine, gives the percentage of total alkaloids in the bark.

Coca (U.S.P. method, a modification of Keller's)

This is one of the most difficult drugs to assay properly, and with our present knowledge it is not practicable to do more than determine the proportion of total ether-soluble alkaloid.

Extraction of the drug.—Place 10 grammes of coca leaves, in No. 60 powder, in a stoppered flask with 10 c.c. of chloroform and 40 c.c. of ether. Shake, stand ten minutes, add 2 c.c. of solution of ammonia and 3 c.c. of water, and shake well at intervals during one hour. Transfer the contents of the flask to a small percolating tube connected with a separator, and, when droppings cease, pack more tightly by aid of a glass rod, and continue percolation with a further 50 c.c. of chloroform-ether mixture. Carefully avoid loss by evaporation.

Extraction as sulphate.—Add to the contents of the separator 6 c.c. of $\frac{N}{1}$ H_2SO_4 and 20 c.c. of water, shake, and draw off the acid solution. Twice repeat the extraction with 10 c.c. of acid-mixture and separate.

Extraction as free alkaloid.—Mix the acid solutions in a separator, make alkaline with ammonia, and shake out with three successive portions (20 c.c. each) of ether. Allow the ether to evaporate spontaneously.

Titration.—Dissolve the residue in 4 c.c. $\frac{N}{10}$ H_2SO_4 and titrate back with $\frac{N}{50}$ KOH, using cochineal as indicator.

Each c.c. of $\frac{N}{10}$ H_2SO_4 in combination with the alkaloids corresponds to 0.03 gramme reckoned as cocaine.

Yield should not be less than 0.5 per cent.

Colchicum Seed

Extraction of drug.—Place 10 grammes of colchicum seed, in No. 60 powder, in a stoppered flask with 100 c.c. of a mixture of—

Ether	77 fluid parts
Chloroform	25 „ „
90-per-cent. Alcohol	8 „ „
Solution of Ammonia	3 „ „

and shake occasionally during twelve hours. Transfer to a percolating tube and collect 50 c.c. (avoiding loss by evaporation), equivalent to 5 grammes of drug. Evaporate to dryness. Dissolve the residue in 10 c.c. of ether, add 5 c.c. of water, stir, and evaporate off the ether.

Preparation of aqueous solution.—Filter the aqueous solution by means of a filtering tube. Redissolve the insoluble matter in 5 c.c. more ether, add 5 c.c. of distilled water, evaporate ether, and filter as before. Wash with 5 c.c. of water.

Extraction as free alkaloid.—Mix the combined aqueous solutions, and shake with three lots (10 c.c. each) of chloroform. Allow the chloroform to evaporate, and dissolve the residue in a little alcohol; evaporate, and dry at 100° C. until weight remains constant.

The weight of alkaloid multiplied by twenty gives the percentage of colchicine. Yield should not be less than 0.45 per cent.

Conium Fruits

Extraction of drug.—Place 10 grammes of conium, in No. 60 powder, in a stoppered flask with 100 c.c. of a mixture of—

Ether	98 fluid parts
90-per-cent. Alcohol	8 „ „
Solution of Ammonia	3 „ „

and shake occasionally during four hours. Transfer to a percolating tube and collect 50 c.c. (avoiding loss by evaporation), representing 5 grammes of drug, and make slightly acid with sulphuric acid.

Extraction as sulphate.—Evaporate the ether on a water-bath at a temperature below 60° C., add 15 c.c. of 90-per-cent. alcohol, and set aside for the ammonium sulphate to crystallise. Filter, wash the crystals with a little alcohol, and nearly, *but not quite*, neutralise the filtrate with sodium carbonate. Solution must be left faintly acid. Evaporate to 3 c.c. on a water-bath, add 3 c.c. of water and two drops of $\frac{N}{1} \text{H}_2\text{SO}_4$, transfer to a percolator, and shake with 10 c.c. of ether to remove fat, which reject.

Extraction as alkaloid.—Make *very slightly alkaline* with powdered sodium carbonate, and shake out with three successive portions (10 c.c. each) of ether.

Determination as hydrochloride.—To the combined ethereal solutions contained in a tared beaker add, drop by drop, 5 per cent. solution of hydrochloric acid, *until in slight excess*, and evaporate the ether over a water-bath at a temperature below 60° C. Add a few c.c. of alcohol and evaporate again to remove excess of acid. Repeat this operation, temperature never exceeding 60° C. Weight of residue multiplied by 0.777×20 gives the percentage of coniine.

Yield should not be less than 0.5 per cent.

Guarana

Extraction of drug.—Shake 6 grammes of guarana, in No. 60 powder, with 120 c.c. of chloroform and 6 c.c. of solution of ammonia at intervals for an hour, and allow to stand for four hours. Filter 100 c.c. (equivalent to 5 grammes of drug) and distil off the chloroform.

Extraction as alkaloid.—Dissolve the residue in 2 c.c. of $\frac{N}{1} \text{H}_2\text{SO}_4$ and 20 c.c. of warm water. Cool, and filter into a separator, washing with a little water. Add 2 c.c. of solution of ammonia and 20 c.c. of chloroform, and shake. Separate, draw off, and repeat with two further portions (10 c.c. each) of chloroform.

Distil off or evaporate the chloroform, and moisten the dry residue with ether. Allow to evaporate spontaneously, and dry in a water-oven, avoiding loss by decrepitation, until weight is constant. The weight multiplied by twenty gives the percentage of alkaloidal principles; these should not be less than 3.5 per cent.

Hydrastis (modification of Keller's process)

Extraction of the drug.—Introduce into a stoppered flask 15 grammes of hydrastis, in No. 60 powder, and 150 c.c. of ether. Shake occasionally during ten minutes; add 5 c.c. of solution of ammonia, and shake at intervals during half an hour. Then add 15 c.c. of water, shake until the material collects into balls, and at once pour off 100 c.c. of the clear solution into a separator.

Extraction as sulphate.—Add 15 c.c. of $\frac{N}{1} \text{H}_2\text{SO}_4$, shake, separate, and draw off the acid liquid. Repeat with two further portions of acid, 5 c.c. each, mixed with 5 c.c. of water.

Extraction as alkaloid.—Place the mixed liquids in another separator, make alkaline with ammonia, and extract with three portions (20 c.c. each) of ether.

Determination as alkaloid.—Allow the ether to evaporate from the mixed ethereal solutions, and dry in a water-oven until the weight remains constant. The weight multiplied by ten gives the percentage of hydrastine. It should not be lower than 2.5 per cent.

Hyoscyamus

This is assayed in a similar manner to that given for belladonna leaves, except that 25 grammes of powdered drug is taken, and the quantity of chloroform-ether mixture is increased to 100 c.c.

The yield should not be less than 0.08 per cent. of alkaloid, reckoned as atropine.

Ipecacuanha

This is most conveniently assayed by taking 20 grammes of the root, in No. 60 powder, and exhausting with alcohol, as described under *Extractum Ipecacuanhæ Liquidum*, afterwards proceeding with the assay as there given.

Jaborandi

Extraction of drug.—Moisten 10 grammes of jaborandi, in No. 60 powder, with 2 c.c. of ammonia and 3 c.c. of chloroform, mix quickly, and pack in a percolating tube. Percolate with chloroform containing 2 per cent. of solution of ammonia until exhausted, about 100 c.c. being generally sufficient.

Extraction as sulphate.—Pour into a separator and extract with 20 c.c. of $\frac{N}{1}$ H_2SO_4 mixed with 10 c.c. of water, divided into three portions.

Extraction as alkaloid.—Transfer the mixed acid liquids to another separator, make alkaline with ammonia, and shake out with 45 c.c. of chloroform, divided into three portions. Allow the chloroform to evaporate, add 7 c.c. $\frac{N}{10}$ H_2SO_4 , and warm. Titrate back with $\frac{N}{50}$ KOH, using cochineal as indicator.

Each c.c. of $\frac{N}{10}$ H_2SO_4 = 0.0206 gramme of alkaloids (mainly pilocarpine). The yield from *Pilocarpus microphyllus* should be about 0.5 per cent. *P. Jaborandi* rarely comes into the market.

Nux Vomica (this is practically the U.S.P. modification of Keller's process)

Extraction of the drug.—Introduce into a stoppered flask 20 grammes of nux vomica, in No. 60 powder, and add 200 c.c. of the following mixture :

Ether	138 c.c.
Chloroform	44 „
90-per-cent. Alcohol	13 „
Solution of Ammonia	5 „

Shake occasionally during two hours, and allow to stand for twelve hours.

Extraction as sulphates.—Filter off 100 c.c. (representing 10 grammes of nux vomica) into a separator, add 15 c.c. $\frac{N}{1}$ H_2SO_4 . Shake carefully to prevent emulsification, separate, and draw off the acid liquid. Repeat the extraction with two further portions (5 c.c. each) $\frac{N}{1}$ H_2SO_4 , mixing them all in a separator.

Extraction as alkaloids.—To the combined acid solutions add 25 c.c. of chloroform and sufficient ammonia to give a distinct alkaline reaction. Shake and separate. Repeat with two further portions (15 c.c. each) of chloroform.

Oxidation of the brucine, by nitric acid, to di-nitro-brucine.—Allow the chloroformic solutions to evaporate, dissolve in 15 c.c. of 3 per cent. H_2SO_4 , and adjust the temperature to 15° C. Add 3 c.c. of a cooled mixture of equal volumes of nitric acid 1.42 and water, shake, and set aside for exactly ten minutes, shaking gently three times during the interval.

Extraction of strychnine.—Add 25 c.c. of 10 per cent. sodium hydroxide solution, rotate, add 20 c.c. of chloroform, separate, and filter the chloroformic solution (having previously moistened the filter with chloroform). Extract twice more with 10 c.c. chloroform each time. Allow the chloroform to evaporate spontaneously, a little amyl alcohol being added to prevent decrepitation. The crystals are occasionally obtained perfectly white, but are more often slightly tinted.

Titration.—To the alkaloidal residue add 6 c.c. $\frac{N}{10}$ H_2SO_4 , about 80 c.c. of water, and titrate back with $\frac{N}{50}$ KOH, using fresh cochineal as an indicator. Each c.c. of $\frac{N}{10}$ H_2SO_4 in combination is equivalent to 0.03317 gramme of strychnine.

The yield of strychnine varies from 1.0 to 1.55 per cent.

NOTE.—Instead of the above, 5 grammes of nux vomica, in fine powder, may be exhausted in a Soxhlet apparatus with a mixture of 40 c.c. of chloroform and 10 c.c. of ether, and the alkaloids shaken out and purified in the usual way. This is Dunstan and Short's process, and gives accurate results.

Opium (official process)

Any variety of opium may be used for tincture of opium, provided that when dry it contains not less than 7.5 per cent. of anhydrous morphine. For every other official galenical, however, it must contain when quite dry not less than 9.5 per cent. nor more than 10.5 per cent. of anhydrous morphine.

Opium yielding when dry more than 10 per cent. of anhydrous morphine may be diluted to that percentage with opium of weaker percentage, or with milk-sugar.

To dilute opium rich in morphine with opium of poorer quality, the percentage strength of the two samples having been ascertained by direct assay, the correct proportions are arrived at by a simple calculation.

Thus, supposing one sample of opium contained 14 per cent. of morphine and another 8 per cent. ; then—

$$\begin{array}{rcl} 14 \text{ per cent.} & = & 4 \text{ over } 10 \\ 8 \text{ ,,} & = & 2 \text{ under } 10 \end{array}$$

Therefore proportionately two parts of the stronger opium (14 per cent.) must be mixed with four parts of the weaker (8 per cent.) to produce six parts of 10 per cent. opium.

Details of assay process.—Triturate together in a small mortar the following :

Opium, dried at 100° C., in No. 50 powder	14 grammes
Lime, freshly slaked	6 ,,
Distilled Water	40 c.c.

When a uniform mixture results add 100 c.c. more water, and stir occasionally during half an hour to promote decomposition of the natural alkaloidal salts.

Filter the mixture into a wide-mouthed stoppered bottle having a capacity of 200 c.c. The filtrate will contain, besides the morphine, which is dissolved in the lime-water, a little extractive, and traces of other alkaloids. Continue filtration until exactly 104 c.c. has collected, corresponding to 10 grammes of the powdered opium.

To the 104 c.c. of filtered liquid add—

Alcohol, 90 per cent.	10 c.c.
Ether	50 ,,

Shake vigorously and add—

Ammonium Chloride	4 grammes
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Shake well and frequently during half an hour ; set aside for twelve hours for the morphine to crystallise out. The precipitation of the alkaloid is brought about by the ammonia liberated by the calcium hydroxide.

Now counterbalance two small filters ; place one within the other in a small glass funnel in such a way that the triple fold of the inner filter rests upon the single fold of the outer filter ; moisten the filters with ether. Remove the ethereal layer of the liquid in the bottle as completely as possible by means of a pipette, and transfer to the filter ; rinse out the bottle with 20 c.c. of ether, allow to separate, and remove by means of a pipette as before ; now wash the filter with 10 c.c. of ether, added slowly and in portions.

NOTE.—The foregoing treatment with ether practically removes all alkaloids except morphine ; a little morphine dissolves in the ether and is lost, but as this loss is constant for the ether used, it is allowed for in the final calculations.

Let the filter dry in the air, and pour the liquid from the bottle in such a way as to transfer the crystallised morphine as completely as possible. When all the liquid has passed through, wash the remainder of the morphine from the bottle with *morphinated water*.

Wash the crystals with *morphinated water* until they are practically free from colour; allow the filters to drain, and dry first by pressing between sheets of bibulous paper, afterwards at a temperature between 55° and 60° C., and finally at 110° C. for two hours; weigh the crystals in the inner filter, counterbalancing with the outer filter.

Check.—Dissolve 0.5 gramme of the crystals obtained as above in 20 c.c. $\frac{N}{10}$ H_2SO_4 , and titrate back with $\frac{N}{100}$ KOH, using cochineal as an indicator. Each c.c. $\frac{N}{10}$ H_2SO_4 in combination = 0.0283 gramme of anhydrous morphine.

The weight of pure anhydrous morphine in the *total weight* of impure crystals, as indicated by twice the titration figure, *plus* 0.104 (correction for loss of alkaloid during process), should not be less than 0.95 and not more than 1.05 grammes, corresponding to about 10 per cent. of anhydrous morphine in the powdered opium.

Example.—Supposing the weight of the crystals in the filter before titration was 1.10 grammes, and that 0.5 gramme of these crystals, titrated as above, indicated 0.48 gramme of *pure* anhydrous morphine. Then 1.1 grammes would contain 1.056 grammes of *pure* anhydrous morphine, and $1.056 + 0.104$ (the correction for loss of morphine during the process) = 1.160 grammes in 10 grammes of the dried opium; therefore, unless required for making tincture of opium, etc., every 86.2 parts of the dry powder of the strength indicated above must be diluted to 100 parts with sugar of milk $\left(\frac{100 \times 10}{11.6} = 86.2\right)$.

Morphinated water is prepared by digesting pure morphine in chloroform-water until the latter is saturated, and filtering.

Physostigma

Extraction of the drug.—Introduce 20 grammes of physostigma, in No. 60 powder, into a 250-c.c. stoppered flask, add 200 c.c. of ether, and shake during ten minutes. Add 10 c.c. of 5-per-cent. $NaHCO_3$ solution, and shake occasionally during four hours.

Extraction as sulphate.—Allow to settle, and decant 100 c.c. (= 10 grammes physostigma) into a separator, make slightly acid with H_2SO_4 , and add 10 c.c. of water. Shake and separate. Twice repeat with acidulated water.

Extraction as alkaloid.—Mix the combined acid solutions in another separator, make alkaline with $NaHCO_3$, and extract with three lots of ether (20 c.c. each).

Titration.—Allow the mixed ethereal solutions to evaporate, and dissolve the residue in 5 c.c. $\frac{N}{10}$ H_2SO_4 and 20 c.c. of *neutral* ether, rinsing with 80 c.c. of water into a flask; add a few drops of cochineal, and titrate the excess of acid with $\frac{N}{50}$ KOH.

Each c.c. of $\frac{N}{10}$ H_2SO_4 = 0.0273 gramme of alkaloid reckoned as physostigmine.

The yield is about 0.15 per cent.

Jalap

Introduce 10 grammes of jalap, in No. 60 powder, into a percolating tube, and slowly percolate with ether until 50 c.c. of percolate has collected. Evaporate the ether in a tared dish. The residue, multiplied by ten, gives the percentage of *ether-soluble resin*.

Continue percolation with rectified spirit until 100 c.c. has been obtained. Transfer 20 c.c. to a separator, add 20 c.c. of chloroform, mix, and add 20 c.c. of water. Shake vigorously for about one minute. Separate and draw off the chloroformic solution into a tared beaker; wash the contents of the separator with 5 c.c. more chloroform. Evaporate the mixed chloroformic solutions over a water-bath, and dry to constant weight. This weight, multiplied by fifty, gives the percentage of *resin insoluble in ether*.

The total yield of resin should not be less than 7 per cent., of which not more than 15 per cent. should be soluble in ether.

Balsam of Peru

Place 1 gramme of the sample in a separator with 30 c.c. of purified ether. Add 20 c.c. of $\frac{N}{2}$ NaOH, shake for about a minute, and set aside until separation takes place. Run off the lower alkaline layer into another separator.

Again shake the ethereal solution, with 10 c.c. of $\frac{N}{2}$ NaOH, draw off the alkaline layer into the second separator, and wash the mixed liquids with 10 c.c. of purified ether, adding the ethereal washings to the first separator. Wash the mixed ethereal solutions with two successive portions (5 c.c. each) of distilled water.

Draw off the purified ethereal solution of cinnamein into a 100-c.c. wide-mouth flask, and heat gently until odour of ether has practically disappeared; add 1 c.c. of absolute alcohol, and dry in a water-oven for half an hour. Cool in a desiccator, and weigh.

The weight of the residue (cinnamein) should not be less than 56 per cent. of the balsam taken.

Fit the flask with a long tube to act as an air-condenser, add 20 c.c. of $\frac{N}{2}$ KOH (alcoholic) and 20 c.c. of rectified spirit, and boil on a water-bath for one hour. Dilute with 50 c.c. of distilled water, add 1 c.c. of solution of phenolphthalein, and titrate back with $\frac{N}{2}$ H_2SO_4 .

Each gramme of oily residue (cinnamein) should require about 0.235 gramme of KOH for saponification.

Example.—

Weight of Balsam taken = 1.408 gramme

„ Cinnamein = 0.836 „

Corresponding to 59.4 per cent.

This requires 7 c.c. $\frac{N}{2}$ KOH for saponification.

1 c.c. $\frac{N}{2}$ KOH = 0.02787 gramme KOH

∴ 7 c.c. „ = 0.19509 „ „

∴ 1 gramme of residue = $\frac{0.19509}{0.836}$ = 0.233 gramme KOH

Balsam of Tolu

Warm 5 grammes of the balsam with 25 c.c. of purified carbon disulphide, and decant. Warm the residue with a further quantity of 10 c.c. of carbon disulphide, and decant the clear solution. Heat the mixed liquids gently until most of the solvent has disappeared, and finish by drying to constant weight.

The residue should be distinctly crystalline, and should require not less than one-third its weight of KOH for saponification when tested as described under Balsam of Peru.

Cantharides (Greenish's process)

Moisten 20 grammes of cantharides (in fine powder) with 3 c.c. of strong hydrochloric acid, pack in a Soxhlet, and extract with 80 c.c. of benzene for one hour on a sand-bath; remove the flask, distil off the benzene, add 105 c.c. of water, and boil for ten minutes under a reflux condenser. Let the oil rise, and pipette off the aqueous liquid into a 500-c.c. separator; repeat the boiling four times with 50 c.c. of water for five minutes. Mix the aqueous liquids and shake out with 30, 30, 20, and 20 c.c., respectively, of chloroform, evaporate the chloroform completely, wash the residue with 5, 5, and 3 c.c. of a mixture of equal parts of absolute alcohol and petroleum ether (previously saturated with cantharidin), filtering through a plug of absorbent cotton in a small funnel; then wash with petroleum spirit till the solvent leaves no residue on evaporation. Wash the cotton, with the adhering cantharidin, with a little chloroform into the flask, dry at about 65° C., and weigh. Yield, 0.3 to 0.8 per cent.

Assay of Plasters having Rubber Basis

Example : Assay of Belladonna Plaster.—Introduce into a beaker 50 c.c. of chloroform, 3 c.c. of solution of ammonia, and 10 grammes of the rubber plaster cut into thin strips. Stir until the plaster is removed from the cloth, and pour off the clear liquid. Wash the residue with 25 c.c. of chloroform and 1 c.c. of solution of ammonia, and add the washings to the first portion. Repeat this operation. Dry the cloth in a water-oven, weigh, and subtract its weight from the 10 grammes of plaster originally taken.

Add to the chloroformic solution 80 c.c. of rectified spirit, stir, and allow to stand until the rubber separates into a compact mass. Decant the supernatant liquid into a separator, washing the rubber with a few c.c. of a mixture of equal parts of chloroform and spirit; add 20 c.c. of $\frac{N}{2}$ H_2SO_4 , and agitate very gently for two minutes, avoiding the formation of an emulsion.

Draw off the chloroformic solution, and again extract it with four more portions (10 c.c. each) of $\frac{N}{2}$ H_2SO_4 .

Mix the acid solutions of alkaloids, alkalise with ammonia, and extract with three portions (10 c.c. each) of chloroform.

Mix the chloroformic solutions of alkaloids in a flask, and evaporate the solvent by the aid of a water-bath. To the dry residue add 1 c.c. of chloroform and 50 c.c. of $\frac{N}{10}$ H_2SO_4 , warming on a water-bath, with an occasional shake, until the chloroform evaporates. Cool, and titrate back with $\frac{N}{50}$ KOH, using cochineal as an indicator.

Each c.c. of $\frac{N}{10}$ H_2SO_4 in combination corresponds to 0.0287 gramme of alkaloid (reckoned as atropine) present in 10 grammes of the spread cloth.

CHAPTER XXXIX

ASSAY OF ESSENTIAL OILS

All essential oils either pre-exist in plants, or are formed under the action of ferments by the splitting-up of resins, glucosides, and similar bodies. The essential oils which occur naturally are sometimes found in distinct cells, as in the glands of the orange and lemon, in tubes, as in the vittæ of umbellifers, or in deep-seated tissue, as in cinnamon bark. In other instances they are found associated with resins, as oleo-resin of copaiba, or with gum-resins, as ammoniacum. Essential oils obtained from different parts of the same plant frequently differ not only in their physical, but in their chemical properties—as oil from cinnamon bark and the oil from the leaves. Unlike fixed oils, essential oils have a harsh feeling when rubbed on the fingers; they are all inflammable, burning with a luminous flame with the production of much carbon.

The greater number are obtained by distilling the oil-bearing parts of the plant with steam; although their boiling-points may be higher than that of water, the oils are carried over in a state of minute division with the aqueous vapour. In this way are obtained the essential oils of chamomile, cloves, cinnamon, cassia, cubebs, eucalyptus, lavender, peppermint, all the oils derived from umbelliferous fruits, etc. The oils from the rinds of the fruits of the *Citrus* species, as lemon and bergamot, cannot be distilled in the ordinary way, but are obtained by expression. The odorous principles of most flowers are so sparingly distributed and of so delicate a character that they cannot be prepared by either distillation or expression. The usual method employed for their extraction consists in placing the flowers between sheets of cotton wool soaked in an odourless hydrocarbon, from which the perfume may be recovered by macerating with purified alcohol (enfleurage). See also Distillation of Volatile Oils and Medicated Waters.

All volatile oils oxidise in contact with air. They should therefore be preserved in well-stoppered bottles away from the light. When required to be dissolved in alcohol, as in the preparation of perfumes, such of them as are soluble should be mixed with an equal bulk of alcohol, it having been found by experience that not only is

oxidation retarded, but in most cases the oil improves in odour, especially on keeping.

In the examination and valuation of essential oils, much may be learned by a careful study of such physical data as are derived from determinations of gravity, rotation, and fractionation; but in such oils as those of lavender and cinnamon, which contain definite odorous principles, it becomes necessary to determine the percentages of such bodies. Exact processes are generally applicable for the assay of the following:

Aldehydes.—Citral, benzoic and cinnamic aldehydes.

Esters.—Bornyl acetate, and other esters of borneol.

Linalyl acetate, and other esters of linalool.

Geranyl acetate, and other esters of geraniol.

Phenols.—Thymol, eugenol, carvacrol.

Alcohols.—Borneol, linalool, geraniol, rose alcohols, santalol, menthol.

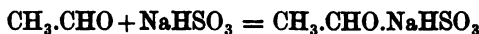
Determination of Aldehydes and Ketones

The following process—Schimmel's—is only applicable to those aldehydes and ketones which form, with concentrated bisulphite of sodium solution, crystalline compounds soluble in boiling water. Such are cinnamic and benzoic aldehydes, and the ketone carvol contained in the oils of dill, caraway, and green mint.

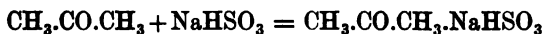
Necessary apparatus.—A glass flask holding about 70 c.c., the neck graduated in c.c. subdivided into tenths. These are known on the market as Hirschsohn's flasks.

Solution of sodium bisulphite, 30 per cent.

About 40 c.c. of the bisulphite solution is brought to the boiling-point in the flask, 10 c.c. of the oil immediately added, and thoroughly agitated for half an hour. Any aldehydes or ketones present combine with the bisulphite to form definite compounds, which dissolve in the hot aqueous solution. The reaction that takes place is analogous to the behaviour of ordinary aldehyde with sodium bisulphite solution:



or with ordinary acetone—

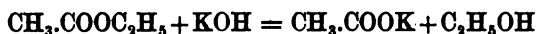


As a rule the bisulphite compound completely dissolves, the non-aldehydes forming a clear oily layer on the surface; but to ensure completion of the reaction the flask should be immersed in a water-bath for a couple of hours or so. The flask is then allowed to cool, and filled up with more bisulphite solution, so that the non-aldehydes may be measured in the graduated neck of the flask. The figure obtained, multiplied by ten, gives the percentage of

non-aldehydes, which, again, deducted from 100, indicates the percentage of aldehyde or ketone.

Determination of Esters (Ethereal Salts)

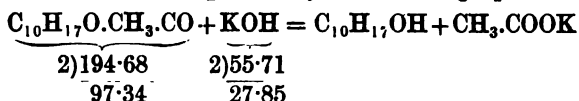
All ethereal salts undergo hydrolysis (saponification) when they are heated with alkalies; thus, ethyl acetate warmed with solution of potassium hydroxide yields potassium acetate and ethyl alcohol:



It follows, then, that the esters in essential oils may be determined by saponifying them with a definite volume of alcoholic potash, titrating back the uncombined alkali with sulphuric acid. The reason for using an alcoholic solution of the alkali is the insolubility of most ethereal salts in water, and the consequent slowness with which the reaction proceeds if aqueous alkali is used.

Take a definite weight of the oil (about 2 grammes), mix with 20 c.c. $\frac{\text{N}}{2}$ KOH (alcoholic), and boil for thirty minutes under a reflux condenser, cool, and titrate the excess of alkali with $\frac{\text{N}}{2}$ H_2SO_4 , using phenolphthalein as an indicator.

Example.—Supposing 2 grammes of French lavender oil is taken for examination, and it is found that 13 c.c. of $\frac{\text{N}}{2}$ H_2SO_4 is required to neutralise the excess of alkali. This indicates that 7 c.c. of $\frac{\text{N}}{2}$ KOH has entered into combination. The principal ester present is linalyl acetate, and the reaction is expressed by the following equation:



That is—

$$1000 \text{ c.c. } \frac{\text{N}}{2} \text{ KOH} = 97\cdot34 \text{ grammes linalyl acetate}$$

$$1 \text{ c.c. } \quad \quad = 0\cdot09734 \text{ gramme } \quad \quad$$

$$\therefore 7 \text{ c.c. } \quad \quad = 0\cdot68138 \quad \quad$$

As 0·68138 gramme of linalyl acetate is contained in 2 grammes, this weight, multiplied by fifty, gives the percentage ($0\cdot68138 \times 50 = 34\cdot06$ per cent.).

NOTE.—The above equation is applicable in calculating the amount of linalyl acetate in bergamot and lavender oils, as well as its isomer bornyl acetate in oil of pine.

Determination of Alcoholic Bodies

In the determination of alcohols, such as menthol in oil of peppermint and borneol in oil of rosemary, advantage is taken of the fact

that these bodies when boiled with acetic anhydride form the acetic ester. This is called acetylation. The ethereal salt is then saponified and determined as previously described, when the percentage of alcohol present is obtained by calculation.

Example.—See *Oleum Menthæ Piperitæ*.

Determination of Phenols

If *exact* results are required, Thom's method must be followed. Briefly, this consists in heating benzoyl chloride with a mixture of alkali and essential oil (oil of cloves, for instance). On cooling, benzoyl-eugenol separates out, and after purification is weighed and calculated to eugenol.

A simpler process consists in treating a definite volume of oil, in a flask having an elongated graduated neck, with 10-per-cent. aqueous solution of caustic potash, warming, and allowing the uncombined oil to rise to the surface, where it is measured at a temperature of 15° C. The difference between the reading and the amount of oil taken is the approximate amount of eugenol present. The process is applicable for the determination of eugenol in oils of cloves, cinnamon, and cassia.

EXAMPLES OF ASSAY PROCESSES ¹

Oleum Amygdalæ Volatile

Determination of benzaldehyde.—Introduce into a 150-c.c. flask 10 c.c. of purified kerosene, *note the exact weight*, add 1 c.c. of the volatile oil, and weigh again; add 20 c.c. of water, with a few drops of phenolphthalein solution, and neutralise exactly with $\frac{N}{10}$ NaOH; shake vigorously.

Add from a burette, gradually, sodium sulphite solution (1 in 5), until 10 c.c. has been added, alternating with enough $\frac{N}{2}$ HCl to maintain the neutrality of the mixture. Add a few more drops of phenolphthalein solution, agitate well, and allow to stand for two hours to ensure a permanent condition of neutrality, and then note the number of c.c. of $\frac{N}{2}$ HCl used.

Carry out a blank test, identical with the foregoing, except that the volatile oil is omitted, and note the amount of $\frac{N}{2}$ HCl used. Subtract the number of c.c. required by the blank from the number required in

¹ For detailed information regarding the testing of essential oils the student is referred to the works on this subject by Schimmel, Parry, etc., and to the numerous papers in the pharmaceutical Press by Umney, Bennett, and others.

the original test; each c.c. of the difference corresponds to 0.0526 gramme of benzaldehyde. Yield, about 85 per cent.

Assay of hydrocyanic acid.—Mix in a 100-c.c. flask 1 gramme of oil of bitter almond with sufficient water and freshly precipitated magnesium hydroxide (washed absolutely free from chloride) to make an opaque mixture of about 50 c.c. Add two drops of potassium-chromate solution, and then from a burette add $\frac{N}{10}$ AgNO_3 until a reddish tint is produced which does not disappear on shaking.

Not less than 7.5 c.c. nor more than 14.9 c.c. of $\frac{N}{10}$ AgNO_3 should be required, each c.c. corresponding to 0.002684 gramme of hydrocyanic acid.

Oleum Cajuputi

Assay of cineol.—Introduce into a beaker 10 grammes of the oil in 50 c.c. of petroleum ether. Immerse the beaker in a mixture of ice and salt, and add phosphoric acid sp. gr. 1.7, drop by drop, until the white magma of cineol phosphate at first formed assumes a yellowish or pinkish tint; then transfer the magma to a pressure filter and wash with cooled petroleum ether, and dry by pressure between two porous tiles. Transfer the dry cineol phosphate to a narrow graduated cylinder, and decompose by the addition of a little warm water. The volume of the separated oily liquid, multiplied by ten, represents the percentage by volume of cineol.

The yield should not be less than 55 per cent.

Oleum Caryophylli

Assay for eugenol.—Into a flask with a long neck graduated in tenths of c.c., put 10 c.c. of oil of cloves and 100 c.c. of 6-per-cent. solution of KOH, and shake for five minutes. When the liquids have separated completely, add sufficient potash solution to raise the lower limit of the oily layer to the zero graduation mark, and read off the amount of residual liquid. This should not be more than 2 c.c., indicating at least 80 per cent. of eugenol.

Oleum Cinnamomi

Assay for cinnamic aldehyde.—Introduce into a flask, graduated in tenths of c.c. on the neck, 10 c.c. of the oil and 10 c.c. of a 30-per-cent. solution of sodium bisulphite, shake, and heat on a water-bath until contents are liquefied; add successive portions (10 c.c. each) of bisulphite, shaking and heating after each addition as before, until the flask is three-fourths filled. Continue to heat it on the water-bath until the odour of cinnamic aldehyde is no longer perceptible.

cool to about 25° C., and add enough bisulphite solution to raise the lower limit of the oily layer to the zero graduation. The residual liquid should not measure more than 2.5 c.c., corresponding to at least 75 per cent. by volume of cinnamic aldehyde.

Oleum Eucalypti

Assay of cineol.—This is carried out as described under *Oleum Cajuputi*; the yield should not be less than 55 per cent.

Oleum Limonis

Assay of citral.—Introduce into a tared 150-c.c. flask about 15 c.c. of the oil and note *exact* weight. Add 5 c.c. of water and a few drops of rosolic acid solution, and neutralise with $\frac{N}{10}$ KOH. Then carry out the determination exactly as described under Assay of Benzaldehyde (oil of bitter almond). Each c.c. of difference corresponds to 0.03802 gramme of citral.

The yield of aldehyde should not be less than 4 per cent.

Oleum Menthae Piperitæ

Assay for ester.—Introduce into a tared flask 10 c.c. of oil of peppermint and note exact weight; add 25 c.c. $\frac{N}{2}$ alcoholic KOH, connect with a reflux condenser, and boil for one hour. After cooling, titrate the residual alkali with $\frac{N}{2}$ H_2SO_4 , using phenolphthalein as indicator.

Subtract the number of c.c. of $\frac{N}{2}$ H_2SO_4 used from the 25 c.c. of $\frac{N}{2}$ KOH, multiply the difference by 9.834, and divide the product by the weight in grammes of the oil taken, to find the percentage of *menthyl acetate*.

Acetylation.—Wash the residual oil repeatedly with water, transfer it to a flask provided with a ground-glass condenser (an acetylation flask), add 10 c.c. of acetic anhydride, about 1 gramme of anhydrous sodium acetate, and boil gently for one hour. Cool, wash the acetylated oil with distilled water, and afterwards with $\frac{N}{1}$ KOH, until the mixture is slightly alkaline to phenolphthalein, then dry with fused calcium chloride and filter.

Transfer to a tared 100-c.c. flask 5 c.c. of the dry acetylated oil, *note the exact weight*, add 50 c.c. of $\frac{N}{2}$ alcoholic KOH, connect with a reflux condenser, and boil for one hour. After cooling, titrate the residual alkali with $\frac{N}{2}$ H_2SO_4 , using phenolphthalein as indicator.

Subtract the number of c.c. of $\frac{N}{2}$ H_2SO_4 used from the 50 c.c. of $\frac{N}{2}$ KOH taken, multiply the difference by 7.749, and divide the product by the weight in grammes of the *dry acetylated oil taken*, less the above difference multiplied by 0.021; the quotient represents the percentage of *menthol* in the oil of peppermint.

There should be not less than 8 per cent. of ester, calculated as menthyl acetate, and not less than 50 per cent. of total menthol (free and as ester).

Oleum Pimentæ

Assay for eugenol.—Ten c.c. assayed as described under Oil of Cloves should yield not less than 65 per cent. by volume of eugenol.

Oleum Rosæ

Determination of saponification value.—Place in a weighing bottle about 2 c.c. of the oil and weigh accurately. Transfer it, by the aid of a little alcohol, to a 100-c.c. flask, and add 20 c.c. of $\frac{N}{2}$ KOH (alcoholic). Connect with a reflux condenser, and boil for thirty minutes on a water-bath. When cool add 50 c.c. of distilled water and a few drops of phenolphthalein, and titrate with $\frac{N}{2}$ H_2SO_4 . Subtract the number of c.c. of $\frac{N}{2}$ H_2SO_4 used from twenty, multiply the difference by 27.87, and divide by the weight in grammes of oil originally taken. This gives the saponification value, and should not be less than ten nor more than seventeen.

Oleum Rosmarini

Ten c.c. assayed as described under Oil of Peppermint should yield 2.5 per cent. of ester, calculated as bornyl acetate, and 10 per cent. of total borneol. The factors in this case are 9.734 and 7.649 respectively.

Oleum Santali

Assay for santalol.—Introduce 10 c.c. of the oil into an acetylation flask with condenser, add 10 c.c. of acetic anhydride and 2 grammes of anhydrous sodium acetate, and boil gently during an hour and a half. Allow to cool, wash with distilled water, and afterwards with $\frac{N}{1}$ NaOH until the mixture is slightly alkaline to phenolphthalein, dry with fused calcium chloride, and filter.

Transfer to a tared 100-c.c. flask 3 c.c. of the dry acetylated oil, note weight, add 50 c.c. $\frac{N}{2}$ KOH (alcoholic), connect with reflux

condenser, and boil gently during one hour. After cooling, titrate the residual alkali with $\frac{N}{2}$ H_2SO_4 , using phenolphthalein as indicator.

Subtract the number of c.c. of $\frac{N}{2}$ H_2SO_4 used from fifty, multiply the difference by 11.026, and divide by the weight in grammes of acetylated oil taken, less the above difference multiplied by 0.021. The quotient gives the percentage of santalol in the oil.

Assayed as above, sandal oil should yield 90 per cent. of alcohols, reckoned as santalol.

NOTE.—The difference referred to above represents the number of c.c. of $\frac{N}{2}$ alcoholic KOH consumed by the acetylated oil.

Oleum Sinapis Volatile

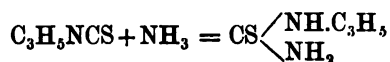
Assay of allyl isothiocyanate.—Weigh accurately 1 gramme of the oil and dilute with 90-per-cent. alcohol to 50 c.c. Transfer 5 c.c. of this solution to a 100-c.c. measuring flask, add 50 c.c. $\frac{N}{10}$ $AgNO_3$ and 5 c.c. solution of ammonia. Stopper, shake, and set aside in the dark for twenty-four hours. Afterwards dilute with water to 100-c.c. mark, shake, and filter.

To 50 c.c. of filtrate add 4 c.c. HNO_3 and a few drops of ferric ammonium sulphate, and sufficient $\frac{N}{10}$ KSCN to produce a permanent red colour. Not more than 5.6 c.c. should be required—each c.c. of $\frac{N}{10}$ $AgNO_3$ consumed corresponding to 0.00492 gramme of allyl isothiocyanate.

Assayed as above, the oil should yield 92 per cent.

(Another Method)

Shake a mixture of 3 grammes of the oil and 3 grammes of alcohol with 6 grammes of solution of ammonia 10 per cent., and heat to 50° C. The mixture will first become clear, and then deposit crystals of thiosinamine. Decant the mother-liquor from the crystals, and evaporate to dryness in a tared dish over a water-bath. Then add the crystals to those in the dish, rinsing out the last portion with alcohol, and continue the heat until the weight remains constant. The amount of thiosinamine obtained from 3 grammes of oil should not fall below 3.25 grammes, corresponding to 92 per cent. by weight of allyl isothiocyanate :



Oleum Thymi

Assay of phenols.—Introduce 20 c.c. of solution of sodium hydroxide 5 per cent. into a 50-c.c. burette. Add 10 c.c. of the oil, cork, shake thoroughly, and set aside for twenty-four hours. Loosen any drops of oil that adhere to the side by tapping, etc. After the alkaline solution has become clear, the volume of non-phenolic oil remaining (which should not measure more than 8 c.c.) is subtracted from the 10 c.c. of oil originally taken.

Assayed as above, oil of thyme should yield 20 per cent. of phenols.

CHAPTER XL

DETERMINATION OF THE OPTICAL ROTATION OF ORGANIC SUBSTANCES

Many organic substances, either liquids or dissolved solids, when examined in a polariscope (fig. 168) are capable of rotating the plane of polarisation of a ray of light either to the right or to the left. Such substances are termed 'optically active.' When rotating to the right they are said to be 'dextro-rotatory,' and when rotating to the left 'lævo-rotatory.' Substances which do not possess the property of optical rotation are termed 'optically inactive.'



FIG. 168.—POLARISCOPE.

Among the substances recognised by the Pharmacopœia there are some, particularly volatile oils, for which the determination of the angle of rotation, or the proof of optical inactivity, affords the simplest evidence of identity or purity.

The instrument most generally useful is the 'half-shadow,' in which the two sides of the field of vision are capable of becoming unequally illuminated. The determinations are best made in a

dark room and by means of monochromatic light, the latter being obtained by introducing into a non-luminous flame a ring of platinum containing fused sodium chloride. The light thus radiated corresponds with the line D of the solar spectrum.¹

Specific rotatory power.—The rotatory power of an optically active liquid substance, observed with sodium light and referred to the ideal density 1, and in a tube 1 decimetre long, is termed its *specific rotatory power*. This is expressed by the term $[\alpha]_D$. Since, however, not only the density of an optically active liquid but also its rotation is influenced by temperature, the specific rotation varies with the latter. In stating the specific rotation, therefore, it is necessary to indicate at what *temperature* the rotation and the density of the liquid have been determined. But for the same temperature, the specification rotation of a pure, optically active liquid is always a constant number. The temperature generally used is 16° C.

For calculating the specific rotatory power of an optically active liquid substance, or solution of an optically active solid, the following formulæ are of general application :

1. For liquid substances : $[\alpha]_D = \frac{100 \times a}{L \times d}$
2. For solutions of solids : $[\alpha]_D = \frac{10,000 \times a}{L \times p \times d}$
or $[\alpha]_D = \frac{10,000 \times a}{L \times c}$

For calculating the above formulæ it is necessary to determine the following factors :

a = The angle of rotation of the liquid or solid observed with sodium light

L = The length of the tube in millimetres

d = The density or specific gravity of the active liquid

p = The amount of active substance in 100 parts by weight of the solution

c = The number of grammes of active substance in 100 c.c. of the solution

Conversion Factors for different Instruments

1° Schmidt and Haensch (sugar scale) = 0.3468° Angular rotation D

1° Angular rotation = 2.8835° Sugar scale, Schmidt and Haensch

1° Schmidt and Haensch = 2.6048° Wild (sugar scale)

1° Wild (sugar scale) = 0.3840° Schmidt and Haensch

1 " " = 0.1331° Angular rotation D

1° Angular rotation D = 0.7511° Wild (sugar scale)

1° Laurent (sugar scale) = 0.2167° Angular rotation D

1° Angular rotation D = 4.6154° Laurent (sugar scale)

¹ For examples showing the use of the polariscope in detecting admixtures of glucose with honey, etc., see a paper by the author in the 'Pharmaceutical Journal,' November 28, 1903.

PART IV



DISPENSING

CHAPTER XLI

GENERAL REMARKS ON DISPENSING

The dispensing or compounding of medicines is one of the most important duties of the pharmacist. The *art of dispensing* may be said to comprise all the methods and details pertaining to the extemporaneous preparation of medicines.

In a well-ordered establishment, when a fresh prescription is handed in, a fair copy is first made in the prescription book, and the prescription itself marked for future reference. The practice of employing a large stamp for this purpose is to be deprecated, as it may possibly obliterate a not too well-defined ingredient or quantity. Indeed, many physicians head their note-paper with a request to place the reference number or stamp on the back of the prescription, and it is to be regretted that the practice has not become general.

The numbering of prescriptions is best performed by an automatic contrivance, as fig. 169. Such machines print the numbers in clear and legible characters and with absolute accuracy, the changes of figures being entirely automatic.

In addition to marking the prescription with a reference number, it is customary to indicate the price. For this purpose a cypher is usually adopted. Any word of ten letters will do, provided it contains no duplicate letters. Some pharmacists use a word containing nine letters only; in that case the tenth is supplied by a sign, as X.

Thus :

F L O R .	A N T H E M .	C H E M I S T R Y X .
1 2 3 4	5 6 7 8 9 10.	1 2 3 4 5 6 7 8 9 10.

Other words are *volumetric*, *mind the fox*, *duplicates*. Adopting



FIG. 169.
AUTOMATIC NUMBERING
MACHINE FOR PRESCRIPTIONS.

Flor. Anthem. as the cypher, a mixture priced 2s. 6d. would be marked $\frac{l}{n}$.

The letters *V. E.* occasionally appear on the side of the prescription, and are abbreviations of the Latin *vide exemplum*. This mark is made when the dispensing of the prescription presents some peculiarity, and directs attention to the copy in the prescription book, where an explanation is given.

Physicians sometimes write *P. P.* at the top of the prescription, thereby indicating that the patient is a 'poor person,' to whom it is an act of charity to charge less than the usual rates.

Having copied the prescription and carefully considered the ingredients, their compatibility, dose, etc., the labels should next be written in a neat and legible manner. Due attention must be paid to the spacing, as a label may be written accurately and legibly and yet not present a good appearance, owing to some of the words being immoderately drawn out or crowded together. The labels themselves should be as neat and plain as possible, without ornamentation in the way of pictures; particularly should medicine labels be free from advertisements of specialities.

Whilst on the subject of prescriptions, it may be as well to mention that should any error in dosage or serious incompatibility be detected in a prescription, it becomes the duty of the dispenser to communicate with the prescriber. This, if possible, should be done without calling the attention of the patient to the fact. If the prescriber lives within a short distance, it is easy to say that the medicine will take a little time to make up, and induce the patient to wait or to call again; but if this course is not open there may remain no alternative but to explain the matter. With a little tact this may often be done without alarming the patient, but in any case the pharmacist must act with the greatest circumspection.

Bottles and Labels

Mixtures.—Mixtures intended for internal administration may be sent out in green flint *oval* bottles. The upper edge of the label should come to within half an inch of the shoulder. If it is necessary to affix a 'shake the bottle' label, it should be placed *above* the directions label, for the reason that careless people frequently tear back the wrapping paper only sufficiently to read the directions, so that any label placed near the base of the bottle is not observed. When any of the ingredients happen to be more than usually potent, as solution of strychnine, arsenic, etc., the words '*by measure glass*' may be introduced into the body of the directions, thus: *One tablespoonful (by measure glass) every four hours.*

Mixtures of smaller bulk than six ounces are generally sent out in white glass vials. When the dose is less than a teaspoonful such

mixtures are termed 'drops.' Of late years the practice of sending out mixtures in bottles purporting to be divided into an equal number of parts has become very prevalent. A properly divided bottle saves trouble in measuring the doses, and as long as the practice is confined to the division in ounces, or even tablespoons, no great harm is likely to ensue. It is, however, unreasonable to expect three- or four-ounce bottles to be graduated in teaspoons with anything approaching accuracy.

Gargles.—Gargles, although intended for internal use, may not always be swallowed with impunity, and for distinction may be dispensed in green flint *flat* bottles. The same applies to spray solutions for the throat and nose. The label should be plainly headed 'The Gargle,' and may be printed on grey or blue-toned paper.

Lotions.—Eye-lotions and other moderately harmless external applications are best sent out in *light green fluted* hexagonal bottles, although some pharmacists prefer deep green bottles of the ordinary flat pattern. A '*not to be taken*' label must always be attached. If the lotion is of a distinctly poisonous nature, such as Goulard's extract, a *deep blue fluted* bottle should be selected, and labelled with the word 'Poison.'

Liniments.—Liniments and poisonous applications generally must be dispensed in *deep blue fluted* bottles of octagonal or other distinctive shape. The shape is of almost greater importance than the colour, so that the bottles may be readily distinguished in the dark by the touch.

After dispensing the medicines ordered, the prescription should be carefully re-read and the labels checked. When making up old and perhaps familiar forms, the memory must not be relied upon, but the prescription or copy should always be open before the dispenser. Although the memory is not to be trusted when compounding prescriptions and manufacturing preparations, it is absolutely imperative for the dispenser to be familiar with the ordinary and maximum doses of all important medicines, as well as the proportion of active ingredients in their official preparations. It is of little moment, for instance, in dispensing Pulv. Opii Comp. whether he remembers the amount of ginger contained in five grains of the powder, but *it is necessary* to realise that one-tenth of the weight consists of powdered opium.

Habits of neatness should be cultivated. To this end the littering of the bench with bottles, books, or apparatus should be avoided, each article being replaced or put away as soon as done with. Before removing a bottle from the shelf let the label be carefully read; the habit of taking bottles from accustomed places without looking at the label is most dangerous. Indeed, in more than one well-known pharmacy a rule is made of *slightly* altering the arrangement of the bottles every morning, with the view to discouraging the practice.

Moistening corks with the lips, licking labels, etc., are objectionable habits. If too large, the cork should be softened by squeezing in a

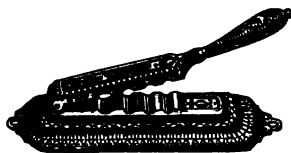


FIG. 170.—LEVER CORK-PRESS.

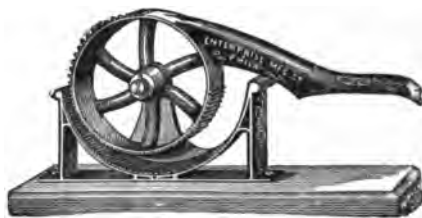


FIG. 171.—ROTARY CORK-PRESS.

FIG. 172.
—LABEL-DAMPER.

cork-press, as fig. 170 or fig. 171. The disadvantage of the lever press is that unless used with judgment it frequently breaks the corks. The rotary cork-press (fig. 171) is a distinct improvement, but is rarely seen in this country. In many dispensing establishments cork-presses are not used, the dispensers preferring to roll the cork beneath a small block of stone or wood.

Label-dampers may take the form shown in fig. 172. Ready gummed labels, however, are not an unmixed blessing, and many pharmacists prefer to affix their labels with paste. A good adhesive is prepared as follows :

Dextrin	1 lb.
Distilled Water	1½ pint

Mix evenly ; dissolve by heat, making up loss by evaporation ; cool and add

Oil of Cloves	1 fl. drachm
-------------------------	--------------

Pour into jars and allow to set. This takes from twenty-four to seventy-two hours, but the result is excellent.

Labelling of Stock Bottles

The labels on stock bottles, whether for the pharmacy or the store-room, should be as plain as possible. For general effect and utility, gold-labelled bottles are still preferred by many pharmacists, although sunk glass labels find numerous applications. In any case, whatever the material of the label, the lettering cannot be too distinct, and should be so arranged that the whole of the label is visible from the front. Labels that extend three-quarters of the way round the bottle are dangerous in the extreme. Fig. 173 shows a label which cannot possibly be misinterpreted ; but that on the bottle fig. 174 might easily be taken to indicate the *simple* powder of ipecacuanha instead of the *compound*, which it purports to. No essential part of

the label should be hidden from view, and no abbreviations should be used which permit of more than one rendering.

The labels on store-room bottles, while not necessarily of the same expensive character as those on the pharmacy shelves, should be equally distinct. If it is not found convenient to employ printed labels, it is at any rate possible for all to stencil them for themselves; and if the blank spaces left by the stencil plates are filled in with Chinese ink, the labels leave nothing to be desired as regards legibility.



FIG. 173.



FIG. 174.

Labels prepared in this way should be left for one or two days to dry, when they may be affixed by flour paste, and then sized with dilute gelatin solution. After another interval of a day or two, they should have a coat of pale paper-varnish, care being taken to extend the varnish well over the edges of the paper to prevent moisture running under. Paper labels treated in this manner will wear for a very long time, but are not suited for bottles containing corrosive liquids. For the last mentioned, labels etched on the glass itself are usually employed.

Stoppering of Glass Bottles

It occasionally happens that glass stoppers do not fit perfectly into the mouth of the bottles to which they belong, or the proper stopper may have become lost or broken, in which case new ones have to be fitted. If the stopper can be moved laterally it may be considered as ill-fitting, and unsuited for the preservation of volatile substances, or such as are readily oxidised or injured by exposure to air.

To render such stoppers air-tight they must be re-ground. This is effected by dipping the stopper into water, and then into emery powder, and placing it in the neck of the bottle, twisting it to and fro until the emery has been ground smooth, when more is applied. After grinding for some time the stopper and the neck of the bottle should be rinsed with water and the fitting examined. If fairly firm the grinding may be finished with fine emery powder and oil.

Removal of fixed stoppers.—The removal of stoppers that have become firmly fixed in the necks of bottles is an operation with which the pharmacist has frequently to deal. There are several causes which give rise to the fixing of glass stoppers, the most frequent being the deposition of resinous or other adhesive matter between the stopper and the bottle neck. Sometimes a salt becomes crystallised there, either from the sublimation of the salt itself, or in consequence of the evaporation of the solvent. In some cases the pressure of the atmosphere, occasioned by contraction of the gaseous contents of the bottle, is the cause of the stopper becoming fixed.

The means of effecting the removal of the stopper must depend on the cause of the adhesion, and on the size, form, and thickness



FIG. 175.
STOPPER EXTRACTOR.

of the bottle and its stopper. Should twisting and pulling fail, the stopper may be gently tapped with the wooden handle of a palette knife. Great care must be taken to regulate the weight of the blows to the size and apparent strength of the bottle. Instead of tapping the stopper, a lever may be used which, fitting closely to the stopper, enables more force to be applied than would be otherwise possible. The lever consists of a piece of hard wood (fig. 175), in which are oblong holes of different sizes, into one of which the stopper of the bottle is placed. As in the use of the palette knife, great care and judgment is required or the stopper may be easily broken off.

If none of the foregoing proves effectual, other means must be adopted. Thus, if resinous or other matter soluble in spirit is the cause of the adhesion, a little alcohol may be placed in the groove between the stopper and the lip of the bottle, and, after allowing some time to elapse, the methods previously described may be repeated. Should the deposit be insoluble in alcohol, other solvents may be tried. If none of these methods proves successful, it may be necessary to warm the neck of the bottle over a *small* Bunsen flame. The immediate result of warming is expansion of the bottle neck, thus relaxing the grasp on the stopper, which may often be readily withdrawn. Care is needed in the application of the heat, as if not warmed uniformly the bottle neck may split; while if the heat is applied too long, it becomes communicated to the stopper, which may or may not expand uniformly with the bottle. Should

the bottle contain a liquid of an inflammable nature, the application of a flame is unsafe, in which case a strip of cloth dipped in hot water may be wrapped round the part to be heated; or a piece of stout string may be passed round the bottle neck, one end being tied to some stationary object, the other held firmly in the left hand. If now the bottle is grasped in the right hand and rapidly moved backwards and forwards, the friction will generate sufficient heat for the purpose. If the stopper cannot be removed by the hand after warming, tapping and levering may be tried before the glass cools.

As prevention is better than cure, it is a wise plan to smear with soft paraffin the stoppers of all bottles that are only occasionally opened; a few twists of the stopper will then effectually distribute the lubricant. The paraffin serves another purpose than preventing sticking of the stopper, for it makes a tighter seal and prevents evaporation. If it is desired to seal the bottle hermetically, the neck and the stopper should be gently warmed, and a little hard paraffin, which has been previously melted in a small capsule, poured carefully into the groove. Ethereal and other liquids having a solvent action on paraffin are best sealed with a mixture made by dissolving one part of gelatin in five parts of water, adding just before use half per cent. of potassium dichromate. After exposure the water evaporates, leaving a film of insoluble gelatin on the stopper or cork.

CHAPTER XLII

THE PRESCRIPTION

Prescription (*præscriptio*—*præ*, before, and *scribo*, I write) is the term applied to the written formula and directions of a physician for the preparation and use of remedies.

A prescription may be divided into four parts; the heading, the designation of the ingredients, the direction to the compounder, and the direction to the patient. In addition, every prescription should bear both the name of the patient and the date, and for reference in case of emergency the name and address of the prescriber.

In ancient times every prescription or formula had at its commencement certain characters or sentences of a pious or superstitious nature, such as + (the sign of the cross); α and ω (the first and last letters of the Greek alphabet), Christ being designated the 'Alpha and Omega, the beginning and the ending'; C.D., *cum Deo*; J.D., *juvante Deo*; L.D., *laus Deo*; N.D., *nomine Dei*, etc. These constituted the *invocation*, or, as it was called, the *inscription*.

The heading.—The symbol \mathcal{R} , or abbreviated *Rec.* (*recipe*, take thou), usually commences every formula, but in French prescriptions the letter P. or the word *Prenez* (take) is usually substituted.

The designation of the ingredients.—Each ingredient should have a separate line. It is customary to write the names of the ingredients in Latin; the quantities should be expressed in apothecaries' weights and measures, the numbers being stated in Roman figures. To minimise the chance of error, every unit should have a dot placed immediately above it, thus: xii, viii. If metrical weights and measures are designated, the greatest care should be observed in making the position of the decimal point plain: thus, 1 gramme, 1.00; 1 decigramme, 0.1; 1 centigramme, 0.01; 1 milligramme, 0.001. When potent remedies are ordered it is safer to write out the quantity in full, thus:

\mathcal{R} Strychninæ 50 milligrammes
Sacch. Lact. q. s.

Make a mass, and divide into thirty pills. One twice a day.

The direction to the compounder as to the manner, form, or method of use of the medicine, constitutes what was originally known as the

subscription, and is generally written in Latin, as 'Misce,' 'Fiat pilula,' etc.

The direction to the patient declares the dose and time of administration if the medicine is intended for internal use, and the method of application if intended for outward use. It is sometimes preceded by the letter S. (*signetur*, let it be entitled). This part of the prescription should invariably be written in English.

There are several reasons for employing Latin in preference to the vernacular in prescriptions, at least for the designation of the ingredients. Latin, if not spoken, is written and understood throughout the civilised world; moreover, Latin professional terms are concise and definite; and, further, the Latin names for drugs and chemicals are nearly the same all over Europe, whereas the vernacular names differ for each nation and sometimes for each province. Lastly, it is occasionally necessary or advisable to conceal from a patient the precise nature of the remedies employed. On the other hand, these reasons do not apply to the use of the Latin language for writing the *directions to the patient*. There are several objections, such as the inability to give in good and intelligible Latin the requisite directions to the patient and the limited acquaintance with Latin possessed by some dispensers.

The signs used in prescriptions.—Formerly the signs or symbols employed in chemistry and pharmacy as substitutes for words were numerous. At the present time they are very few. The following alone deserve notice:

- ℞. *Recipe*, take thou. Ancient authors use the sign \mathfrak{J} , being the old invocation to Jupiter.
- ℥. *Minimum*, the one-sixtieth part of a fluid drachm.
- Gtt. *Gutta*, drop.
- gr. *Granum*, a grain.
- ʒ. *Scrupulus* or *scrupulum*, a scruple, equal to twenty grains.
- 3. *Drachma*, a drachm, equal to three scruples, or in liquids the eighth part of a fluid ounce.
- ℥. *Uncia*, an ounce apothecaries', or in liquids the twentieth part of an imperial pint.
- ℥. *Octarius*, a pint.

The rules for the grammatical construction of a prescription would be out of place here, and the reader is referred to the excellent 'Latin Grammar of Pharmacy,' by the late Joseph Ince, to the 'Selecta à Præscriptis' of Dr. Pereira, on which the writer has drawn largely, and Bennett's new 'Medical and Pharmaceutical Latin.'

An explanation of a prescription written entirely in Latin may be useful.

- ℞ (1) Ferri Carbonatis ʒiiss.
 (2) Rhei Pulveris gr. xv.
 (3) Conservæ Rosæ, quantum sufficiat, ut fiat massa in
 pilulas viginti dividenda, quarum sumat æger tres
 octavis horis.

- (1) *Recipe*, verb active, imperative mood, second person singular, agreeing with *tu* (understood); governs the accusative case.
drachmam, noun substantive, accusative singular, feminine, first declension, governed by *recipe*.
unam, numeral, accusative, singular, feminine, agreeing with *drachmam*.
cum, preposition, governing ablative.
semisse, substantive, ablative case, governed by *cum*.
Carbonatis, substantive, genitive singular, masculine, third declension, governed by *drachmam*.
Ferri, substantive, genitive singular, neuter, second declension, governed by *carbonatis*.
- (2) *Recipe* (understood).
grana, substantive, accusative plural, neuter, second declension, governed by *recipe*.
quindecim, adjective, indeclinable.
Pulveris, substantive, genitive singular, masculine, third declension, governed by *grana*.
Rhei, substantive, genitive singular, neuter, second declension, governed by *pulveris*.
- (3) *Recipe* (understood).
quantum, adverb, governing the genitive.
sufficiat, verb, impersonal, potential mood, present tense, active, third conjugation.
Conservæ, substantive, genitive singular, feminine, first declension, governed by *quantum*.
Rosæ, substantive, genitive singular, feminine, first declension, governed by *conservæ*.
ut, conjunction, governing subjunctive mood.
massa, substantive, nominative case, feminine, first declension.
fiat, verb, subjunctive, present tense, third person singular, governed by *ut*, and agreeing with its nominative *massa*.
dividenda, gerundive, nominative case, feminine, agreeing with *massa*.
in, preposition, governing accusative.
pilulas, substantive, accusative plural, feminine, first declension, governed by *in*.
viginti, adjective, indeclinable.
quarum, relative pronoun, genitive plural, feminine, agrees with its antecedent *pilulas* in number, gender, and person; governed in the genitive case by *tres*.
æger, adjective, masculine gender, nominative, agreeing with *homo* (understood).
sumat, verb, third person singular, imperative, active, third conjugation, agreeing with *homo* (understood).
tres, adjective, accusative plural, feminine, agreeing with *pilulas* (understood).

horis, substantive, ablative plural, feminine, first declension, signifying part of time, and therefore put in the ablative case.
octavis, adjective, ablative plural, feminine, agreeing with *horis*.

LATIN TERMS USED IN PRESCRIPTIONS, WITH THE MORE COMMONLY OCCURRING ABBREVIATIONS

<i>Latin</i>	<i>Contracted form</i>	<i>English</i>
A, ab, abs	a	by or from
Abdomen	abd.	the belly
Absente febrī	abs. febr.	fever being absent
Absque	absq.	without
Ac		and
Accidit		it happens
Ad		to, up to
Adde	ad.	add
Addendo	add.	by adding
Addendus	add.	to be added
Ad duas vices		for two times
Adeps suillus		lard
Adhibendus	adhib.	to be administered
Ad libitum	ad lib.	at pleasure
Admove	admov.	apply
Ad secundam vicem	ad sec. vic.	to the second time
Adstrictus	ads.	bound
Ad tertiam vicem	ad ter. vic.	for three times
Ad tres vices		for three times
Æger, ægra	æg.	the patient
Affectare	aff.	to affect
Agere		to act
Agitato phiala	agitat. phiala	the bottle being shaken
Alter	alt.	the other
Alternis horis	alter. horis	every other hour
Alvo adstricta	alv. ads.	when the bowels are confined
Alvus	alv.	the belly (the bowels)
Ambo	amb.	both
Amplus	amp.	full, large
Ampulla	amp.	a large bottle
Ana	a., aa., āā	of each
Ante	ant.	before
Aperiens	aper.	aperient
Apud		at, near
Aqua bulliens	aq. bull.	boiling water
Aqua communis	aq. com.	common water
Aqua destillata	aq. dest.	distilled water
Aqua fervens	aq. ferv.	boiling water
Aqua fluvialis	aq. fluv.	river water
Aqua fontana	aq. font.	spring water
Aqua pluvialis	aq. pluv.	rain water

<i>Latin</i>	<i>Contracted form</i>	<i>English</i>
Aquosus	aq.	watery
Auratus		golden
Auris		the ear
Aut		or
Balneum	baln.	a bath
Balneum tepidum		a warm bath
Bene		well
Bibe	bib.	drink (thou)
Biduum	bid.	two days
Bis		twice
Bis in die	b. i. d.	twice a day
Bolus	bol.	a large pill
Brachio sanguis emittatur		let blood be taken from the
Brachium		an arm [arm
Brevis	brev.	short
Bulliens	bull.	boiling
Cæterus ; et cætera	cæt. ; et cæt.	the other ; and so forth
Calefactus	calef.	warmed
Calidus	calid.	warm
Calomelas	calom.	calomel
Calor		heat
Cape	cap.	take (thou)
Capiat	cap.	let him take
Capillus		a hair
Capsula		a capsule
Caput		the head
Cataplasma	catap.	a poultice
Caute		cautiously
Ceratum	cerat.	a cerate
Cibus	cib.	food
Circa	circ.	around
Circiter	circ.	about
Cochleare	coch.	a spoon
Cochleare amplum	coch. amp.	a tablespoon
Cochleare magnum	coch. mag.	a tablespoon
Cochleare minimum	coch. min.	a teaspoon
Cochleare parvum	coch. parv.	a teaspoon
Cochleatim	cochleat.	by spoonfuls
Colatur	colat.	let it be strained
Colatus	colat.	strained
Collutorium	collut.	a mouth wash
Collyrium	collyr.	an eye wash
Compositus	comp.	compound
Concisus	concis.	sliced
Confectio	conf.	a confection
Congius	cong., C.	a gallon

<i>Latin</i>	<i>Contracted form.</i>	<i>English</i>
Conritus	cont.	bruised
Contusus	cont.	bruised
Coque	coq.	boil (thou)
Cortex	cort.	the bark
Cras	cr.	to-morrow [ing]
Cras mane sumendus	c. m. s.	to be taken to-morrow morn-
Cras nocte	c. n.	to-morrow night
Cras vespere sumendus	c. v. s.	to be taken to-morrow even-
Crus		the leg [ing]
Cujus	cuj.	of which
Cum	c	with
Cyathus	cyath.	a cup, wineglass
Cyathus vinarius	cy. vinar.	a wineglass
De		from
Deaurentur pilulæ	deaur. pil.	let the pills be gilded
Decanta	decant.	pour off
Decem		ten
Decoctum	dec.	a decoction
Decubitus	decub.	lying down
Decubitûs horâ	decub. hor.	at bedtime
De die in diem	de d. in d.	from day to day
Deinde	deind.	then, the next
Dens		a tooth
Dexter		the right side
Diebus alternis	dieb. alt.	every other day
Diebus tertiis	dieb. ter.	every third day
Dies	d.	a day
Dilutus	dil.	diluted
Dimidium	dimid.	half
Dividatur in partes æquales	divid. in p. æq.	let it be divided into equal parts
Donec		until
Donec alvus soluta fuerit	don. alv. sol. fuer.	until the bowels are opened
Donec dolor exulaverit	donec dolor ex.	until the pain is removed
Dosis	dos.	a dose
Drachma	dr.	a drachm
Dulcis	dulc.	sweet
Dum		until
Duo		two
Duplex	dup., dx.	double
E, ex		out of, from
Eadem	ead.	the same
Ejusdem	ejus.	of the same
Electuarius	elect.	an electuary
Electus	elect.	selected
Emeticum	emet.	an emetic

<i>Latin</i>	<i>Contracted form</i>	<i>English</i>
Emplastrum	emp.	a plaster
E vehiculo crasso	e vehic. crass.	in a thick vehicle
Exhibeatur	exhib.	let it be exhibited
Ex tempore		at the time
Extende	extend.	spread
Extende super alutam mollem	ext. sup. alut. moll.	spread upon soft leather
Extractum	ext.	an extract
Fac	f.	make (thou)
Facies		the face
Febricula	febr.	fever
Febri durante	febr. dur.	during the fever
Febris	febr.	a fever
Fervens	ferv.	boiling
Fiat	ft.	let it be made
Fiat haustus	ft. hst.	let a draught be made
Fiat mistura	ft. mist.	let a mixture be made
Fiat pilula	ft. pil.	let a pill be made [art
Fiat secundum artem	ft. s. a.	let it be made according to
Flatus	flat.	breathing (flatulence)
Folium	fol.	a leaf
Fortis	fort.	strong
Fotus		a fomentation
Frigidus	frigid.	cold
Frustillatim	frust.	in little pieces
Fuscus	fusc.	brown
Gallicus	Gall.	French
Gargarisma	garg.	a gargle
Genu		the knee
Gradatim	grad.	by degrees
Granum	gran.	a grain
Gummi	gum.	a gum
Gutta	gutt., gtt.	a drop
Guttatim	guttat.	drop by drop
Guttis quibusdam	gtt. quib.	with a few drops
Haustus	hst.	a draught
Heri		yesterday
Hirudo	hirud.	a leech
Hodie		to-day
Hora	hor.	an hour
Horâ decimâ matutinâ	h. dec. matut.	at ten in the morning
Horâ decubitûs	hora decub.	at bedtime
Horæ unius spatio		in an hour's time
Horâ somni	h. s.	at bedtime

<i>Latin</i>	<i>Contracted form</i>	<i>English</i>
Ibi		there
Idem	id.	the same
In		into
Incisus	incis.	cut, sliced
Indies		daily
Infunde	infund.	pour in
Infusum	inf.	an infusion
In pulmento	in pulm.	in gruel
Inspissare	insp.	to thicken, inspissate
Inter		between
Intime	intim.	intimately
Involvere	involv.	to roll in
Jecur		the liver
Jentaculum	jentac.	breakfast
Julepus	julep.	a julep
Juxta		near to
Lac		milk
Latus		the side
Laxativus	laxat.	a laxative
Libra	lb.	a pound
Lignum	lign.	wood
Linimentum	lin.	a liniment
Liquor	liq.	a solution
Lotio	lot.	a lotion
Macerare	mac.	to macerate
Male		ill
Mane	m.	in the morning
Mane primo	m. prim.	very early in the morning
Manipulus	manip.	a handful
Manus		the hand
Massa	m.	a mass
Medicamentum	med.	a drug
Mensurâ	mens.	by measure
Meridies	merid.	midday, noon
Mica panis	mic. pan.	crumb of bread
Minimum	min., m.	a minim, smallest
Misce	m.	mix
Misce bene	m. b.	mix well
Mistura	mist.	a mixture
Mitis		mild
Mitte	mit.	send
Modo præscripto	mod. pr.	in the manner prescribed
Mollis	moll.	soft
More dictu	m. dict.	in the way directed
More solito	mor. sol.	in the usual manner

<i>Latin</i>	<i>Contracted form</i>	<i>English</i>
Nimis		too much
Nisi		unless
Nocte	noct.	at night
Non repetatur	non rep.	do not repeat
Nucha capitis	nuch. cap.	the nape of the neck
Numero	no.	in number
Octarius	oct., O.	a pint
Oculus	oc.	the eye
Omni biduo	om. bid.	every two days
Omni bihorio	om. bihor.	every two hours
Omnibus alternis horis	om. alt. hor.	every other hour
Omni horâ	om. h.	every hour
Omni mane	om. m.	every morning
Omni nocte	om. n.	every night
Omni quadrante horæ	om. quad. hor.	every quarter of an hour
Omnis	om.	all
Pars		a part
Partem affectam	part. aff.	the affected part
Partem dolentem	part. dol.	the painful part
Partes æquales	p. æq.	equal parts
Partitis vicibus	part. vic.	in divided doses
Parvulus	parv.	small
Pastillus	past.	a pastille
Pauxillum	paux.	a little
Per		through, by
Pes, pedis	ped.	a foot
Pharmacopœia Britannica	Ph. B.	The British Pharmacopœia
Pharmacopœia Dublinensis	Ph. D.	The Dublin Pharmacopœia
Pharmacopœia Edinensis	Ph. E.	The Edinburgh Pharma- copœia
Pharmacopœia Londin- ensis	Ph. L.	The London Pharmacopœia
Pilula	pil.	a pill
Pocillum	pocill.	a little cup
Poculum	poc.	a cup
Pollex	poll.	the thumb
Ponderosus	pond.	heavy
Postea	post.	afterwards
Post jentaculum	p. jent.	after breakfast
Post meridiem	p. mer.	the afternoon
Post prandium	p. prand.	after dinner
Post singulas sedes liquidas	p. sing. sed. liq.	after every liquid stool
Pro ratione ætatis	p. rat. æt.	according to the age of the
Pro re natâ	p. r. n.	occasionally [patient
Proximâ luce	prox. luc.	on the following morning
Pugillus	pug.	a pinch
Pulvis	pulv.	a powder

<i>Latin</i>	<i>Contracted form</i>	<i>English</i>
Quantum	q., quant.	as much
Quantum libet	q. lib.	as much as desired
Quantum sufficiat	q. s.	a sufficiency
Quaque	qq.	each, every
Quâque quartâ horâ	q. q. hor.	every four hours
Quartus	quart.	the fourth
Quater	quat.	four times
Quaterve	quat.	four times
Quies		quiet
Quinques	quinq.	five times
Quotidie	quotid.	daily
Recipe	R̄	take (thou)
Redigatur in pulverem	redig. in pulv.	let it be reduced to powder
Regio		region, part
Repetatur	rep.	let it be repeated
Rursus		again
Scatula	scat.	a box
Scrobiculus cordis	scrob. cord.	the pit of the stomach
Secundum artem	s. a.	according to art
Semel		once
Semidrachma	semidr.	half a drachm
Semihora	semih.	half an hour
Semis	ss.	half
Sequenti luce	seq. luce	the following morning
Sesquihora	sesquih.	an hour and a half
Sesuncia	sesunc.	an ounce and a half
Si		if
Signatura	signat.	a label
Signe	sig.	write (thou)
Simul	sim., s.	together
Sine	s.	without
Singulorum	sing.	of each
Singulus	sing.	single, each
Si non valeat	s. n. valeat	if it does not answer
Si opus sit	s. o. s.	if there be occasion
Solve	solv.	dissolve
Somnus	somn.	sleep
Spiritus vini rectificatus	s. v. r.	rectified spirit
Spiritus vini tenuior	s. v. t.	proof spirit
Statim	st.	at once, immediately
Stet	st.	let it stand
Sufficiens	suff.	sufficient
Sumat	sum.	let him take
Sumatur	sum.	let it be taken
Sume	sum.	take (thou)
Sumendus	sum.	to be taken
Super	sup.	upon

<i>Latin</i>	<i>Contracted form</i>	<i>English</i>
Tabella	tab.	a lozenge
Talis	tal.	such, like this
Tempori dextro	temp. dext.	to the right temple
Ter	t.	thrice, three times
Tere		rub (thou)
Tere simul	t. s.	rub together
Ter in die	t. i. d.	thrice daily
Tinctura	tr.	a tincture
Tot		so many
Totus		the whole
Triduum	trid.	three days
Trochiscus	troch.	a lozenge
Tussis	tus.	a cough
Ultimo præscripto	ult. præsc.	the last ordered
Uncia	unc.	an ounce
Ut dictum	ut dict.	as directed
Vas vitreum	vas. vit.	a glass vessel
Vel	v.	or
Venæ		the veins
Venenum	ven.	poison
Vesper	vesp.	the evening
Vices	vic.	times
Vitellus	vit.	yolk
Vomitus	vomit.	vomiting
Vulnus		a wound

TERMS LIKELY TO OCCUR IN FRENCH AND GERMAN PRESCRIPTIONS ¹

À, *Fr.*, to, or. Trois à quatre paquets (three or four powders).

Abendessen, Abend- brod, -mahlzeit, -tisch, *Ger.*, supper. Drei von diesen Pillen vor dem Abendessen (three of these pills before supper).

Bisse, *Ger.*, bolus. Sechs Bissen im Tage zu nehmen auf drei Gaben vertheilt (six boluses to be taken daily, divided into three doses).

Bol, *Fr.*, bolus. À prendre six bols par jour en les partageant en trois doses (six boluses to be taken every day, dividing them into three doses).

Coucher, *Fr.*, bedtime, going to bed. A prendre deux pilules avant le coucher (two pills to be taken at bedtime).

Cuillerée à café, *Fr.*, teaspoonful. Une cuillerée à café au cas d'une attaque de toux (a teaspoonful to be taken if the cough comes on).

¹ Abstracted, by permission, from 'The Art of Dispensing' (*C. & D.*).

Cuillerée à soupe, *Fr.*, tablespoonful. Prenez une cuillerée à soupe toutes les deux heures (one tablespoonful every two hours).

L'effet voulu, *Fr.*, the desired effect. Une cuillerée à café toutes les demi-heures jusqu'à l'effet voulu (a teaspoonful every hour till it acts).

Einspritzung, *Ger.*, injection.

Essen, *Ger.*, meals.

Esslöffel, *Ger.*, tablespoon. Alle zwei Stunden einen Esslöffel-voll (a tablespoonful every two hours).

Flasche, *Ger.*, bottle. Schütteln sie die Flasche (shake the bottle well).

Fois, *Fr.*, time. Prenez en quatre fois à une demi-heure d'intervalle (to be taken in four portions at intervals of half an hour).

Glas, *Ger.*, glass, tumbler.

Gouttes, *Fr.*, drops. À prendre dix gouttes trois fois par jour (ten drops to be taken thrice daily).

À jeun, *Fr.*, fasting. Prenez deux ou trois de ces pilules à jeun (take two or three of these pills fasting).

Latwerge, *Ger.*, electuary.

Lavement, *Fr.*, enema.

Mal, *Ger.*, time, portion. Auf vier Mal in halbstündigen Zwischenräumen zu nehmen (to be taken in four portions at intervals of half an hour).

Mittagessen, *Ger.*, dinner (properly the midday meal). Dieses Pulver unmittelbar vor dem Mittagessen zu nehmen (this powder to be taken immediately before dinner).

Nüchtern, *Ger.*, sober, fasting. Vier oder sechs von diesen Pillen nüchtern zu nehmen (four or six of these pills to be taken fasting, or before breakfast).

Oblate, *Ger.*, wafer. Ein Pulver vor der Mahlzeit in einer Oblate zu nehmen (a powder to be taken in a wafer before meals).

Ordonnance, *Fr.*, prescription.

Pain azyme, *Fr.*, wafer. Un de ces paquets à prendre dans du pain azyme avant le repas (one of these powders to be taken in a wafer before meals).

Paquet, *Fr.*, a packet, powder. À prendre un paquet toutes les deux heures (one powder to be taken every two hours). On prend un de ces paquets peu de temps avant l'attaque de fièvre (one of these powders to be taken shortly before the fever fit).

Pastillen, *Ger.*, lozenges. Man nimmt von diesen Pastillen auf einmal nur eine alle zwei Stunden (one only of these lozenges to be taken every two hours).

Pastilles, *Fr.*, lozenges. À prendre de quatre à six pastilles par jour (four to six lozenges to be taken daily).

Pillen, *Ger.*, pills. Zwei Pillen jeden Abend vor dem Zubettegehen (two pills every evening at bedtime).

Pilules, *Fr.*, pills. Deux pilules chaque soir avant le coucher (two pills every evening at bedtime).

Pincée, *Fr.*, a pinch. Infusez une pincée de ces herbes avec un demi-litre d'eau bouillante pour faire une tisane (infuse a pinch of these herbs in half a pint of boiling water to make a draught).

Potion, *Fr.*, mixture, potion.

Poudre, *Fr.*, powder. Matin et soir une poudre dix minutes avant le repas (one powder ten minutes before meals every morning and evening).

Pulver, *Ger.*, powder. Ein Pulver jeden Morgen und Abend zehn Minuten vor dem Essen (one powder every morning and evening ten minutes before meals).

Repas, *Fr.*, meals.

Rezept, *Ger.*, prescription.

Schlafengehen, *Ger.*, bedtime. Vor dem Schlafengehen zwei Pillen zu nehmen (two pills to be taken at bedtime).

Schnupfen, *Ger.*, to snuff. Fünf bis sechs Mal im Tage zu schnupfen (to be snuffed five or six times daily).

Table, *Fr.*, a table. Se mettre à table (to dine). A prendre deux de ces pilules en se mettant à table (two pills to be taken before dining).

Theelöffel, *Ger.*, teaspoon. Ein Theelöffelvoll (a teaspoonful.)

Tisch, *Ger.*, table. Zu Tische gehen (to dine). Man nehme zwei von diesen Pillen als man zu Tische geht (take two pills before dining).

Tropfen, *Ger.*, a drop. Drei Mal täglich zehn Tropfen zu nehmen (ten drops to be taken three times a day).

Verordnung, *Ger.*, prescription.

Verre, *Fr.*, glass, tumbler. Un verre d'eau sucrée (a tumbler of sugar and water).

Wirkung, *Ger.*, action, effects. Ein Theelöffelvoll alle halbe Stunden bis zur Wirkung zu nehmen (take a teaspoonful every half-hour till it acts).

Zubettegehen, *Ger.*, bedtime.

CHAPTER XLIII

MIXTURES

The rapid strides made in therapeutics during recent years have resulted in the introduction of an almost endless variety of remedial agents. These may be presented in mixtures in so many combinations that a detailed description is impossible. The author, therefore, proposes only to consider some typical examples¹ and to indicate the general rules observed in compounding

- (a) Simple mixtures.
- (b) Mixtures containing resinous tinctures or liquid extracts.
- (c) Mixtures containing insoluble powders.
- (d) Mixtures containing fats, fixed or volatile oils, or other substances requiring emulsification.
- (e) Chlorine mixtures.
- (f) Mixtures containing incompatibles.

(a) SIMPLE MIXTURES may contain a salt or other substance soluble in water, with tinctures and perhaps some flavouring agent as syrup. The menstruum may be one of the official medicated waters or an infusion :

Potassium Citrate	3ij.
Tincture of Orange	3iv.
Syrup	3iv.
Distilled Water to	3vj.

Dissolve the salt in a portion of the water and strain through a plug of absorbent cotton into the bottle ; wash through with more water. Add the tincture and syrup, and make up² with water. Solutions of dirty salts should always be strained through cotton, as a mixture containing extraneous matter is very unsightly. Tinctures, etc., are added to the strained solution.

¹ For further examples and more detailed information regarding dispensing problems the student is referred to MacEwan's 'Art of Dispensing,' from which the author has been kindly allowed to abstract.

² Proceedings have been instituted for incorrect dispensing where the error was manifestly due to the use of inaccurate bottles. Mixtures should, therefore, be always made up to the required volume in a graduate.

Infusions or decoctions should be set on first—before the prescription is copied—so as to cause the least delay. No menstruum should be used while hot on account of the danger of dissolving salts which might crystallise on cooling. When the quantity of a salt ordered is in excess of its solubility, it should be reduced to powder, and the menstruum added perfectly cold :

Potassium Chlorate	℥iv.
Glycerin	℥iv.
Infusion of Roses to	℥vj.

In the last example, as indeed in all cases where there is a sediment, a '*shake the bottle*' label should be attached.

(b) MIXTURES CONTAINING RESINOUS TINCTURES OR LIQUID EXTRACTS generally require the addition of mucilage to render them slightly and to enable an even dose to be taken :

Potassium Bromide	℥iij.
Tincture of Indian Hemp	℥iss.
Chloroform Water to	℥vj.

Dissolve the salt in a portion of the water—straining if necessary—add three drachms of mucilage of acacia, and mix. Pour in the tincture in such a way as not to touch the sides of the bottle, invert once or twice, and fill up with the menstruum.

Should any difficulty be experienced in emulsifying a resinous tincture or liquid extract in this manner, the mucilage may be mixed with a portion of the water in a measure, and the preparation stirred in with a glass rod.

Resinous tinctures, etc., in common use are those of myrrh, guaiacum, benzoin, tolu, hydrastis, etc.

(c) INSOLUBLE POWDERS are frequently prescribed in mixtures. When the powder is of low gravity, as magnesia or rhubarb, or when it diffuses easily or remains suspended while a dose may be taken, the mixture may be dispensed without any addition :

Magnesium Oxide (light)	℥ij.
Magnesium Sulphate	℥vj.
Peppermint Water to	℥vj.

On the other hand, dense powders, as bismuth oxynitrate, require the addition of some suspending agent. The substances usually employed are tragacanth and acacia :

Bismuth Oxynitrate	℥ij.
Tincture of Calumba	℥iv.
Syrup of Ginger	℥iv.
Infusion of Orange to	℥vj.

Place the bismuth in the bottle with two ounces of the water and

shake ; add two fluid ounces of tragacanth mucilage and again shake ; add the tincture and syrup and fill up.

Sometimes tragacanth is ordered in the form of powder :

Bismuth Oxycarbonate	3ij.
Sodium Bicarbonate	3iij.
Powdered Tragacanth	3j.
Distilled Water to	3vj.

Mix the powders intimately, and add all at once about half the water. Triturate quickly until an even mixture is obtained. Transfer to the bottle, washing out the mortar with further portions of the water to fill up. Some dispensers prefer to use an equivalent quantity of mucilage, and proceed as in the earlier example. Some medical men order the compound powder of tragacanth, and it makes a very useful suspending agent. It is treated according to the second example, care being taken to add enough water to prevent a stiff paste being formed.

Acacia has not the same value as a suspending agent as tragacanth on account of its tendency to form cement-like compounds with some powders.

(d) EMULSIONS.—The term *emulsion* is generally applied to the milk-like mixture formed by the suspension of small globules of oil or fat in water. If cod-liver oil, for instance, is vigorously shaken with two or three times its volume of water, an opaque mixture is formed which requires to rest for some time before it separates into distinct layers. If now a small quantity of mucilage of acacia is added and the mixture again shaken, the liquid will become milky, and will require to rest for a very much longer time before separation again takes place. The reason for this non-separation is the partial emulsification of the oil. When oil by itself is agitated with water, it breaks up into a number of globules which again coalesce when the liquid comes to rest, but if a mucilage is added, each globule becomes coated with a film which prevents it from uniting with its neighbours. Experiment has shown that the smaller the globules, and the more perfectly they are coated, the more persistent will be the resulting emulsion.

The emulsifying agents in general use are acacia, tragacanth, dextrin, gelatin, casein, decoction of Irish moss, malt extract, yolk of egg, and soap. Of these, acacia, tragacanth, dextrin, and Irish moss are more commonly employed for mixtures, while yolk of egg and soap are frequently used for liniments and outward applications.

Acacia.—Gum acacia is used both in powder and mucilage form.

Cod-liver Oil	4 fluid ounces
Powdered Acacia	1 ounce
Syrup of Orange	$\frac{1}{2}$ fluid ounce
Cinnamon Water to	8 fluid ounces

Place the powder in a dry mortar of the capacity of at least a pint

and triturate with the oil until mixed. Add, all at once, two fluid ounces of cinnamon water, and stir until the mixture thickens and appears creamy. Scrape down any unmixed portions and continue stirring for several minutes, adding, by degrees, the syrup and sufficient menstruum to produce eight fluid ounces.

If salts are ordered, they must be previously dissolved in the water. Glycerin, alcohol, and syrups should always be diluted with some of the menstruum before adding to an emulsion.

The above proportions may be varied slightly according to the viscosity of the oil. Thus, castor oil may be emulsified with considerably less gum than almond oil or cod-liver oil. Volatile oils, on the contrary, require a larger proportion.

By a second method, the mucilage is prepared with gum and water, and the oil added by degrees, each portion being thoroughly incorporated before addition of the next. This process requires much longer for its completion than that first described, and is more liable to go wrong. If the oil is added too quickly, in nine cases out of ten it ruins the operation, and the spoiled materials can only be used up by starting a fresh batch, and, when the familiar crackling sound is heard, adding them very cautiously to the concentrated emulsion.

A modification of the above process consists in adding the oil and water in equal proportions, but alternately, to the thick mucilage. The result is practically the same as the above, but requires longer for its accomplishment.

Tragacanth.—Emulsions prepared with tragacanth have perhaps less tendency to separate owing to their viscosity, but under the microscope the globules of oil are seen to be much larger than they would be if emulsified with acacia. The following proportions produce moderate results :

Cod-liver Oil	4 fluid ounces
Powdered Tragacanth . .	40 grains
Rectified Spirit	1 fluid drachm
Water to	8 fluid ounces

Place the gum and alcohol in a perfectly dry bottle of about twice the capacity of the emulsion, and mix by shaking; add half the water, all at once, and shake briskly; add the oil, and, after further agitation, any flavouring agent. Volatile oils require rather more tragacanth.

Irish Moss.—Irish moss emulsions are perhaps more successful when made on a manufacturing scale than when prepared at the dispensing bench. The moss must first be well washed with cold water, then placed in a water-bath with the water and heated for about twenty minutes. The most satisfactory strength for the

mucilage is fifteen grains to each ounce of water. This, when cold, is capable of emulsifying an equal weight of fixed oil, the latter being added by degrees, trituration or beating being continued the whole time.

The author has found that a very satisfactory emulsion can be made as follows :

Cod-liver Oil	8 fluid ounces
Powdered Acacia	1 ounce
Mucilage of Irish Moss (15 grains per ounce) to . .	16 fluid ounces
Elixir of Saccharin } . . .	to taste
Flavouring }	

Place the powdered gum in a mortar, add the oil, and mix ; add three fluid ounces of the mucilage and triturate until a good primary emulsion results. Dilute this, triturating constantly, with the remainder of the mucilage, to which the flavouring ingredients have been added.

Casein.—Casein as an emulsifying agent has been strongly recommended, but has not received much attention in this country. One gallon of skim-milk is warmed to 38° C., two fluid ounces of solution of ammonia added, and the whole, after well mixing, set aside to separate. The lower layer is drawn off and acidified with acetic acid. After well washing the precipitated casein with tepid water, it is collected on a calico strainer, strongly pressed to get rid of moisture, mixed with 150 grains of sodium bicarbonate, and sufficient sugar that the product contains 10 per cent. of casein. The resulting pasty mass is spread out in a thin layer, and dried at a temperature not exceeding 38° C.

Emulsions of the fixed oils are made by rubbing ten parts of the saccharated casein with three parts of water, adding by degrees ten parts of oil. After thorough trituration the mixture is diluted to the required extent with water. Resinous substances are not so readily emulsified by casein as by gum arabic, but fairly stable preparations may be turned out by dissolving the resin in a little alcohol before adding to the casein mucilage. It has been claimed that casein emulsions are more readily digested than the corresponding ones prepared with gum.

Yolk of egg.—The yolk of an ordinary egg is equal in emulsifying power to about two drachms of gum acacia or fifteen grains of tragacanth.

Break the shell by a smart blow on the edge of a tumbler or measure, and separate the yolk as cleanly as possible. After rubbing perfectly smooth, the oil is added by degrees, stirring constantly, a little water being added from time to time as the emulsion thickens ; strain through muslin. Well-made egg emulsions bear the addition

of acids exceedingly well, an excellent example being the 'white oils' so popular in rural districts.

Extract of malt.—Perhaps one of the most important pharmaceutical preparations of the present day is emulsion of cod-liver oil with malt extract. The operation of mixing, however, rarely succeeds in the hands of the retail pharmacist. Some have endeavoured to shorten the process by adding a strong tincture of quillaia to the malt, or even powdered gum arabic. These additions are not necessary and are not to be recommended. The most successful results are obtained by mixing the oil and malt in the proportion one to four; the ingredients are placed in a mixing machine and the beaters revolved slowly for some hours, during which time air is excluded as much as possible.

Quillaia.—The inner bark of *Quillaia saponaria* contains a glucosidal principle (saponin) soluble in alcohol and hot water, which possesses remarkable emulsifying properties. The most useful form for employing this agent is a strong decoction, prepared by exhausting the coarsely bruised bark with boiling water, evaporating over a water-bath, and adding 25 per cent. of alcohol when cold. One fluid part of the finished preparation should represent one part by weight of bark.

It is not known whether preparations of quillaia possess the same medicinal properties as other drugs containing saponin—senega, for instance—and for this reason, although its physical properties are so well known, it is but rarely used. As regards its strength, one part of strong decoction, made as above, is sufficient to emulsify ten parts of fixed oil or three parts of volatile oil; emulsions prepared with this agent remain permanent on the addition of either alkalies or acids.

Gelatin.—Gelatin is not infrequently used for emulsions. The most convenient form for keeping it is glyco-gelatin:

Glycerin	5
Gelatin	10
Water	50

Allow the gelatin to soften in the water, dissolve by heat, add the glycerin, and strain through muslin.

One part of this mixture will emulsify its own weight of fixed oil.

The great drawback to gelatin and Irish moss lies in their proneness to decomposition. Chloroform is probably the best preservative agent.

Examples

Fixed oils.—

Castor Oil	1 fluid ounce
Powdered Acacia	2 drachms
Syrup	4 fluid drachms
Water	sufficient to produce 3 fluid ounces

Place the gum in a dry mortar and triturate with the oil; add six

drachms of distilled water, and stir until a thick creamy emulsion is formed ; dilute gradually to two ounces, and add the syrup previously mixed with the remainder of the water.

Volatile oils.—

Oil of Turpentine	1½ fluid drachms
Powdered Tragacanth	10 grains
Syrup	4 fluid drachms
Water	sufficient to produce 3 fluid ounces

Introduce the tragacanth into a *perfectly dry* bottle, add the oil, and shake ; add, all at once, half the water ; shake vigorously, and when thoroughly emulsified add the syrup mixed with the remainder of the water.

Chloroform or Bromoform.—

Chloroform	30 minims
Almond Oil	4 fluid drachms
Powdered Acacia	1 drachm
Powdered Tragacanth	10 grains
Water	sufficient to produce 4 fluid ounces

Mix the gums in a dry mortar ; add the chloroform and oil previously mixed, and triturate gently ; add, all at once, an ounce of water and stir rapidly ; gradually add the remainder of the water, and finish off as quickly as possible.

Another excellent mixture (not an emulsion) is :

Bromoform	32 minims
Alcohol, 90-per-cent.	2 fluid drachms
Glycerin to	1 fluid ounce

This mixture may be diluted with water without the bromoform being thrown out.

Salol.—

Salol	2 drachms
Almond Oil	4 fluid drachms
Powdered Acacia	2 drachms
Syrup	4 fluid drachms
Water	sufficient to produce 6 fluid ounces

Melt the salol in a porcelain dish with the oil ; pour on to the gum contained in a warm mortar ; add one ounce of hot water, and triturate until a creamy emulsion is produced ; dilute gradually to four ounces, and add the syrup mixed with the remainder of the water.

Balsam of tolu.—

Balsam of Tolu	1 drachm
Rectified Spirit	4 fluid drachms
Powdered Acacia	3 drachms
Syrup	4 fluid drachms
Water	sufficient to produce 4 fluid ounces

Heat the tolu balsam in a porcelain capsule, add the spirit, and dissolve; strain through muslin into a mortar with the gum, and add, all at once, half an ounce of water; stir briskly until a good emulsion is formed; gradually dilute to two fluid ounces. Add the syrup dissolved in the remainder of the water.

Lanolin.—

Lanolin	2 drachms
Powdered Soap	1 drachm
Water	sufficient to produce 4 fluid ounces

Place the lanolin in a warm mortar, and when melted add the powdered soap; mix and add, all at once, four fluid drachms of *hot* water; triturate briskly, and add the remainder of the water by degrees.

Spermaceti.—

Spermaceti	2 drachms
Yolk of one Egg	
Syrup	4 fluid drachms
Water	sufficient to produce 4 fluid ounces

Powder the spermaceti with a drop of almond oil, add the syrup, and rub into a perfectly smooth paste. Now triturate with the yolk of egg and dilute gradually with the water.

Cocoa butter, Waxes.—

Cocoa Butter	1 drachm
Almond Oil	1 fluid drachm
Powdered Acacia	1 drachm
Distilled Water	2 fluid ounces

Make a mortar hot with boiling water. Wipe perfectly dry and introduce the fat; as soon as it melts add the oil and gum, and triturate gently. Now add, all at once, half an ounce of boiling water and stir briskly. Gradually add the remainder of the water (warm).

Extract of male fern.—

Liquid Extract of Male Fern	20 minims
Fresh Milk	1½ fluid ounces

Gum-resins, such as ammoniacum and myrrh, require powdering and moistening with water. Brisk trituration then yields a very good emulsion, which only requires diluting and straining. In this case the natural gum present is sufficient to emulsify the resin without further addition.

Resinous tinctures are readily emulsified with a little fresh mucilage, equal parts being sufficient as a general rule. Mix the mucilage with a little water, pour into the bottle, and rotate so as to coat the inside and prevent the resin adhering to the glass. Now by degrees add the tincture, agitating *gently* after each addition.

Seeds.—Certain seeds, such as almonds, form excellent emulsions. The almonds are first blanched by means of hot water, and powdered very finely. A *little* water is next added and the whole beaten into a stiff paste. After well working, water is added by degrees, and the finished emulsion strained through muslin.

General remarks.—No mention has been made as to the use of alkalies in the preparation of emulsions. The omission is intentional, as their indiscriminate use cannot be recommended. Caustic alkalies may, however, in certain cases be used for the emulsification of fixed oils intended for outward application—*e.g.*, Lin. Ammonia. Here excess of oil is shaken with solution of ammonium hydroxide, the small amount of soap that is formed producing a creamy-white emulsion which persists for a long time. Soft soap is frequently made use of to suspend tarry and other matters for outward application. Thus—

Soft Soap	. . . . .	4 drachms
Stockholm Tar	. . . . .	4 „
Rectified Spirit	. . . . .	4 fluid ounces

Dissolve the soap in the spirit and mix with the tar. On pouring the clear mixture into water, an excellent emulsion is formed, which persists for a considerable time.

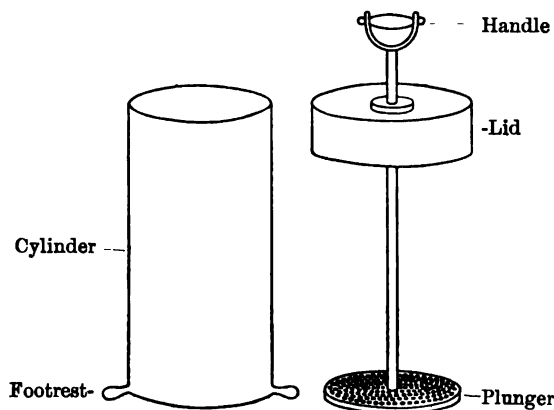


FIG. 176.—EMULSIFIER.

Manufacture of emulsions on a large scale.—The emulsions usually required in quantity are those of cod-liver oil, castor oil, and petroleum. Probably the machine shown in fig. 176 is the simplest.

Mix the gum and oil and place in the cylinder. Add the water, all at once, and work the piston up and down, keeping the feet on the

rests, as considerable exertion² is¹ required. The mixture is violently forced through the small holes, emulsification being so rapid that a few dozen strokes are ample for the production of a permanent emulsion. It is important that the plunger fit closely and accurately into the cylinder.

Proportions—

Cod-liver Oil	1 gallon
Powdered Acacia	1 pound
Irish Moss Mucilage 2½ %, flavoured to taste, and containing any salts . . .	to produce 2 gallons

A power machine is shown in fig. 177.



FIG. 177.—POWER EMULSIFIER.

(e) CHLORINE MIXTURES.—These are occasionally prescribed for gargling the throat—

Potassium Chlorate	40 grains
Hydrochloric Acid	15 minims
Distilled Water to	8 fluid ounces

Introduce the powdered salt into a stoppered bottle and add the acid. Stopper securely and warm the bottle in hot water or over a small flame. When the reaction is complete, pour in an ounce or so of water and agitate so as to dissolve the liberated gas, then make up with water.¹

(f) MIXTURES CONTAINING INCOMPATIBLES.—Incompatible substances cannot exist together in solution without change, nevertheless mixtures containing incompatibles are frequently met with. Sometimes the combination is intentional—

Zinc Sulphate	2 grains
Lead Acetate	4 „
Liquid Extract of Opium . .	30 minims
Distilled Water to	3 fluid ounces

In this injection part of the lead is precipitated as sulphate and part as meconate, acetates of zinc and of the alkaloids remaining in solution.

The following is another example of an incompatible prescription which should always be dispensed as written—

Quinine Sulphate	8 grains
Potassium Iodide	20 „
Potassium Bicarbonate . . .	120 „
Tragacanth	20 „
Distilled Water to	8 fluid ounces

It is difficult to lay down any general rule for the treatment of incompatible prescriptions; but, if any of the ingredients are likely to interact and produce *dangerous* decomposition products, it becomes the duty of the pharmacist to communicate with the prescriber.

In no case should medicine be sent out which, in the judgment of the dispenser, is likely to cause unpleasant symptoms or endanger the patient's life. If, on the other hand, no harm is likely to accrue from mixing incompatible substances, the dispenser should, unless he has reason to believe it to be due to an oversight, compound the medicine as elegantly as may be.

Combinations such as the following are DANGEROUS :

Poisonous Alkaloidal Salts with alkalies, alkaline or earthy carbonates, soluble arsenates, tannic acid, astringent tinctures, borax, iodides, and bromides.

¹ Distilled water is most conveniently kept in glass carboys—of the capacity of two gallons—provided with a tap. If the water is kept in an ordinary 'shop-round,' the air displaced in filling another narrow-necked vessel invariably gains access. In many cases this is not of much consequence, but in some instances it may have unlooked-for results. Thus, in making a chlorine gargle, sufficient chlorine may find its way into the water-bottle, afterwards to liberate iodine from potassium iodide; or if a bottle containing ammonia is filled up, enough ammonia may be dissolved to precipitate alkaloids from neutral solutions.

Thus :

Strychnine Sulphate	1 grain
Potassium Bromide	6 drachms
Distilled Water	6 fluid ounces

This mixture remains clear for some time after mixing, but ultimately deposits crystals of strychnine bromide, and unless the bottle is well shaken before each dose, the probability is the patient will receive a poisonous quantity with the last.

Although alkalies are incompatible with solutions of alkaloidal salts, it does not follow that the alkaloid will *always* be precipitated. The following mixture (from the 'C. & D.') remains clear :

Solution of Strychnine Hydrochloride	40 minims
Sodium Bicarbonate	120 grains
Distilled Water to	8 fluid ounces

Strychnine is soluble 1 in 5700, and as the mixture in question is more dilute (1 in 9600) no deposition of crystals takes place.

The following is also a dangerous type of mixture :

Mercuric Chloride	2 grains
Potassium Iodide	240 "
Solution of Strychnine Hydrochloride	120 minims
Infusion of Orange to	8 fluid ounces

Here a double iodide of mercury and potassium is formed, which precipitates the strychnine.

A mixture that at first sight does not appear to be unsafe is :

Solution of Strychnine Hydrochloride	4 fluid drachms
Elixir of Gluside (Saccharin) to	2 fluid ounces

Here the alkaloid is thrown out by the soda of the soluble saccharin.

Antipyrine with nitrites, persalts of iron, sodium salicylate, chloral hydrate, tannic acid, mercuric chloride, phenol, and β -naphthol.

Thus :

Sodium Bromide	240 grains
Antipyrine	120 "
Chloral Hydrate	120 "
Syrup of Lemon	1 fluid ounce
Distilled Water to	4 fluid ounces

On mixing, an insoluble oily compound (which may afterwards crystallise) of phenazone and chloral is formed.

Another objectionable mixture that has been noticed consists of

Phenazone	60 grains
Sodium Salicylate	180 "
Potassium Bromide	240 "
Magnesium Sulphate	1 ounce
Glycerin	$\frac{1}{2}$ fluid ounce
Distilled Water to	8 fluid ounces

On standing, a copious deposit of crystals containing phenazone associated with magnesia and salicylic acid is formed.

If it is specially desired to combine spirit of nitrous ether with phenazone, sodium bicarbonate should be added to prevent the formation of iso-nitroso-phenazone, which otherwise imparts a green colour to the mixture.

Arsenic Salts with salts of magnesia, mercuric chloride, or astringents.

Arsenates must not be dispensed with solutions of alkaloids.

Bromides with poisonous alkaloids (see also Iodides). It may not be generally known that bromides are incompatible with paraldehyde—bromate being formed.

Chloral Hydrate with antipyrine. Alkalies and alkaline carbonates liberate chloroform.

Iodides with poisonous alkaloids, chlorates, and spirit of nitrous ether (unless containing free alkali).

The 'C. & D.' has recorded an *apparently* harmless mixture containing ferrous iodide and potassium chlorate which caused death :

Potassium Chlorate	120 grains
Syrup of Ferrous Iodide	6 fluid drachms
Antimonial Wine	30 minims
Spirit of Chloroform	2 fluid drachms
Distilled Water to	8 fluid ounces

This mixture is almost colourless when first prepared, but rapidly turns brown, and after a few days deposits crystals of iodine.

Soluble iodides or bromides must not be dispensed with mercurous salts :

Potassium Bromide	10 grains
Calomel	3 „

On rubbing together, metallic mercury separates, and a poisonous double salt, mercuric-potassium bromide, is formed.

The following mixture, although not dangerous, is often seen, and is a wonderful example of incompatibility :

Potassium Iodide	30 grains
Quinine Sulphate	12 „
Dilute Sulphuric Acid	18 minims
Distilled Water to	6 fluid ounces

After standing for a few hours a red crystalline deposit of iodo-sulphate of quinine (herapathite) is formed. If mucilage of acacia is first added, the deposit is amorphous and easily distributed.

Nitroglycerin Solution with aqueous menstrua, unless the mixture contains sufficient alcohol to keep it in solution.

Spirit of Nitrous Ether forms dangerous mixtures with iodides and bromides, unless free alkali is present. It is also incompatible with phenazone and salicylates.

Salicylates, although not forming dangerous compounds, form brownish mixtures with alkalis, alkaline carbonates, and ammonia.¹

Strychnine. See Poisonous Alkaloids.

EXPLOSIVE COMBINATIONS

It occasionally happens that substances are ordered in prescriptions which, if brought together in the ordinary way, may combine with explosive violence.

Chlorates should not be rubbed in a mortar or heated with—antimony sulphide, carbolic acid, catechu, creosote, gallic acid, glycerin, hypophosphites, iodine, iodol, lycopodium, oxalic acid, salicylic acid, shellac, sugar, sulphur, or tannic acid.

Erythrol Tetranitrate must not be powdered with any readily oxidisable substance. When required in powder it may be safely triturated in a perfectly clean mortar with a *wooden* pestle.

Hypophosphites may decompose violently when heated or rubbed with chlorates.

Iodine ignites oil of turpentine. It should not be mixed with strong solution of ammonia on account of the danger of forming nitrogen iodide—one of the most dangerous of explosive compounds.

Iodol decomposes with violence when mixed with chlorates or with mercuric oxide.

Phosphorus inflames spontaneously in air, and should always be kept under water. When required for dispensing, it should be lifted out on the point of a knife or sharp wire, quickly dried with clean blotting-paper, and weighed as rapidly as possible—on a counterpoised watch-glass, and *not* on a metal scale-pan.

Picric Acid and **Picrates** should not be triturated violently. When heated in the dry, especially with calcium oxide, they may explode.

Potassium and **Sodium** should be preserved under benzine or other suitable hydrocarbon. Especial care should be taken when handling not to bring any piece into contact with water.

Potassium Dichromate or **Chromic Anhydride** must not be mixed with glycerin or alcohol.

Potassium Permanganate or other permanganates may give rise to an explosion when mixed with glycerin, alcohol, sulphides, fats, oils, or sugar.

¹ A very complete list of incompatibles is contained in the 'Art of Dispensing' by Peter MacEwan.

Silver Oxide explodes when rubbed with creosote, phenol, or potassium permanganate. If, however, it is diluted with kaolin and then massed with a hydrocarbon, it may be made into pills without much risk. Pills containing silver oxide, if massed with syrup, glucose, or other reducing agent, swell up and crumble, but rarely explode.

Explosions sometimes occur in mixtures containing bismuth oxynitrate and other acid compounds, and alkaline carbonates or bicarbonates. This is due to liberation of carbon dioxide.

CHAPTER XLIV

POWDERS AND CACHETS

The division of all powders intended for internal administration should be performed with the utmost exactitude, and in no case should the lazy and inaccurate method of subdivision by means of measures be resorted to. Flattening out a powder and dividing it into apparently equal proportions by means of a spatula, is an even worse offence.

For rapid weighing hand balances are generally preferred to the pillar pattern. In some balances one scale-pan is made of glass, and unless great care is exercised the edges chip, which, if uncorrected, impairs the accuracy of the weighing.

Paper for wrapping powders should be plain white with a glazed surface. When one or two dozen powders have to be wrapped, it is convenient to lay down all the papers on the bench in rows and weigh out the whole number before commencing to fold any. Wrapping is



FIG. 178.—POWDER FOLDER.



FIG. 179.—POWDER FOLDER.

accomplished by folding the paper away from the operator to within half an inch of the margin; the further edge is then folded inwards and again on itself, making a double pleat, when the ends are finally doubled over equally on one of the devices shown in figs. 178 and 179.

Powders are generally sent out in card boxes, and the appearance is greatly enhanced if the height of the packets corresponds exactly with the depth of the box. Hygroscopic powders, such as lithium citrate, should be wrapped in *paraffined* paper.

Cachets.—The essential qualities of a perfect cachet are convenience of form, tastelessness, and ready solubility. The basis from which cachets are stamped is perhaps of the least harmful nature possible, consisting merely of flour and water. This material after it has been dipped in cold water becomes quite soft and limp, and powders enveloped in it are swallowed without difficulty.

Directions for filling and closing.—In the apparatus shown in figs. 181 to 184, the shells are pressed with the fingers into the spaces in the plates B and A. The plate C is then folded over on its hinge,

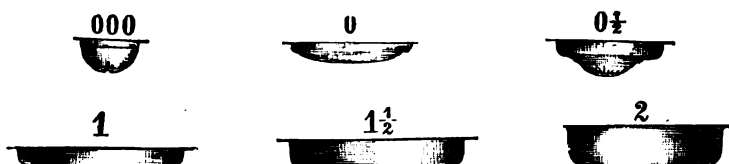


FIG. 180.—EMPTY CACHETS.

No. 000	will hold	1½ grains of quinine sulphate
„ 0	„ 3 to 4½	„ „
„ 0½	„ 6 to 7½	„ „
„ 1	„ 9 to 10½	„ „
„ 1½	„ 10½ to 15	„ „
„ 2	„ 15 to 18	„ „

and serves to protect the rim of the cachet from contact with the powder. The powder is next introduced by means of the small funnel, as shown in fig. 182, and pressed down with a thimble.

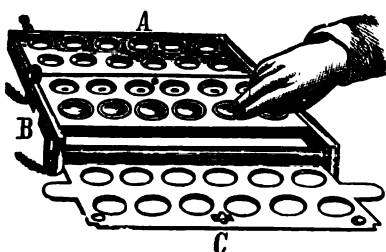


FIG. 181.

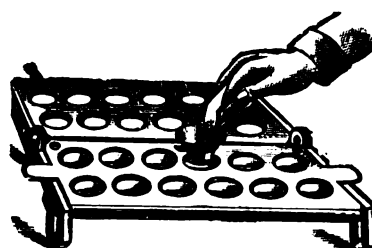


FIG. 182.

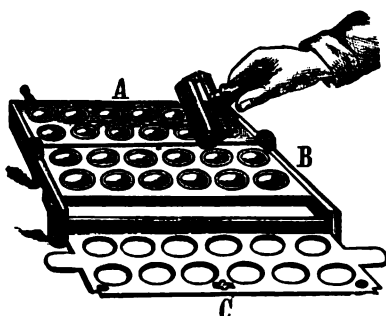


FIG. 183.

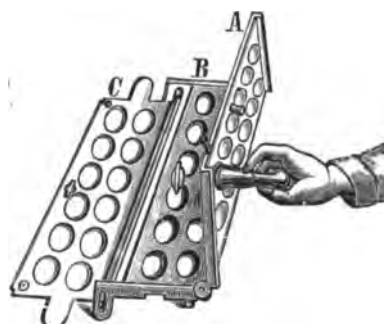


FIG. 184.

CACHET APPARATUS.

When all the cachets have been filled, the plate C is lifted up, and the damping roller, which must not be too wet, passed over the edges of the cachets in the plate (fig. 183). A is then closed over B, and

a slight pressure closes all the cachets at once. The cachets are pressed out on to a sheet of paper to allow the edges to dry and harden, before being touched with the fingers.

Smaller forms of apparatus are worked on the same principle, the difference being that only three cachets of one size are closed at a time instead of twelve (fig. 185).

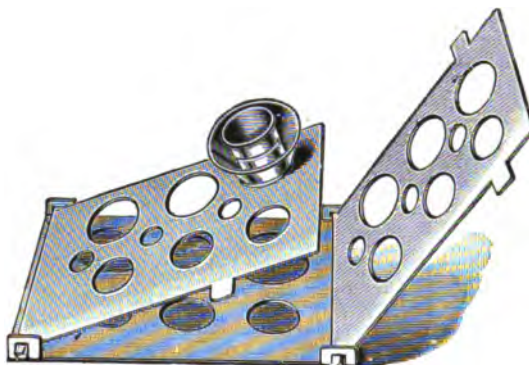


FIG. 185.

Lately an improved form of cachet has been introduced under the name of *Koseal*. In this, the shape of the rim has been altered on the inside by raising a portion, as will be seen in fig. 186. The object of this is to simplify the process of moistening, as some difficulty is occasionally experienced in obtaining just the right degree of dampness when closing the cachets. If made too wet, ordinary



FIG. 186.



FIG. 187.



FIG. 188.

cachets are liable to crinkle and look unsightly at the edges, and if insufficiently moistened they do not cohere. Figs. 187 and 188 show the finished 'koseal.' If considerable pressure is used in closing these, their appearance differs in no way from ordinary cachets, but if slight pressure is employed the two halves only cohere around the raised rim, the finished cachet appearing, as in the last figure.

CHAPTER XLV

PILLS

Pills are small ovoid or spherical masses of medicament, intended to be swallowed whole, without previous mastication. Their weight may vary from one to five grains, but occasionally, when the medicament is very dense, they may weigh as much as ten grains without being abnormally large. Very small pills are sometimes erroneously called *granules*.

A practical acquaintance with the art of pill-making, both extemporaneously and in bulk, is of the first importance to the pharmacist, as the preparation of a good pill-mass requires judgment as well as manipulative dexterity.

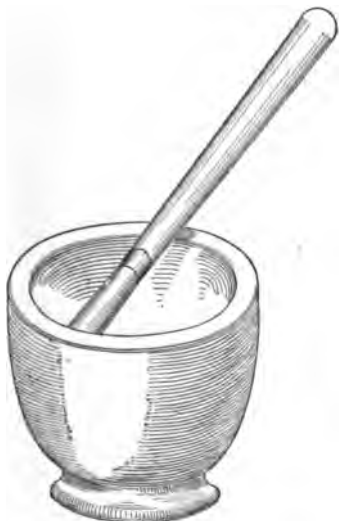


FIG. 189.—PILL-MORTAR.



FIG. 190.—METAL MORTAR.

Pill-apparatus.—For the preparation of small quantities of pills at the dispensing counter, the mortar used for massing the ingredients should be of Wedgwood ware, somewhat shallow, with well-rounded edges. Many pill-mortars are provided with a spout, a useless and inconvenient addition. The pestles supplied with the mortars are, as a rule, much too short: it is found by experience

that the handle should not be less than eight inches in length, almost cylindrical, with a well-rounded end that will fit comfortably into the palm of the hand when kneading, as fig. 189. Mortars for larger quantities are frequently made of bell-metal or iron, as fig. 190, some of the older patterns being often beautifully moulded. To assist in

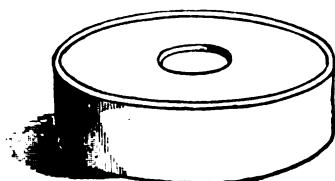


FIG. 191.—MORTAR-COVER.



FIG. 192.—PILL-ROUNDER.

kneading the mass, as well as to prevent loss of material when pounding a dry substance, these metal mortars are provided with stout wooden covers, as fig. 191.

A good operator can frequently manipulate a pill-mass so deftly that scarcely any of the material will finally adhere to the bottom of the mortar; but as *during* the operation the mass generally requires loosening, special knives are employed, having short stiff blades. These should have well-rounded handles, enabling them to be used

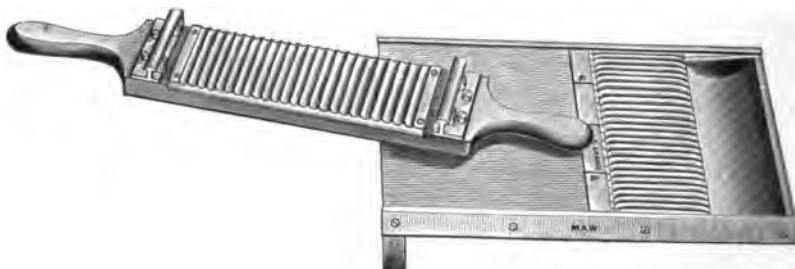


FIG. 193.—PILL-MACHINE.

with comfort. The machine for piping and dividing the mass into pills is usually made of mahogany, with brass runners and cutting surfaces, as fig. 193. In cutting pills by hand, it is necessary that the machine should rest on a firm bench or counter, as considerable force is exerted in rolling hard masses.

The pills as a rule are not perfectly round when they leave the grooves, and to finish them off they are rolled in an eccentric manner beneath a rounder (fig. 192), made of either boxwood or metal, a little starch being used to prevent their sticking together.

The advantage of using a metal pill-finisher is that it can be warmed over a Bunsen burner for very hard pills. Many pharmacists make use of a thick slab of iron, heated over a gas flame, for softening very hard pill-masses. It should not be resorted to where heat is likely to injure the ingredients.

Preparation of the mass.—The pill-mass may be divided into two parts—the active ingredients, and the excipient or material used to bind the mass and give it proper consistence. In the first place, all the dry ingredients must be in very fine powder; in fact, other things being equal, the finer the powder, the more plastic the mass.

The chief characteristics of well-made pills should be uniformity of dose and size, as well as ready solubility when introduced into the system. For the production of pills complying with the above conditions the ingredients must be thoroughly mixed before the addition of any excipient. Potent remedies, such as the toxic alkaloids, should be carefully diluted with a little milk-sugar before mixing with the bulk of the material. It occasionally happens that a fraction of a grain of some very active ingredient is ordered in a pill, which it is impossible to weigh directly. In these cases, the substance may be mixed with milk-sugar in such proportions that an aliquot part can be weighed off. Thus, if twenty-four pills are required, each containing $\frac{1}{80}$ of a grain of strychnine, one grain of the alkaloid should be intimately mixed with nine grains of diluent, and eight grains of the mixture taken, representing $\frac{8}{10}$ or $\frac{4}{5}$ of a grain. Or it may happen that twenty-four pills are ordered, each containing $\frac{1}{24}$ of a grain of the active ingredient. In this case it is more convenient to weigh one grain, afterwards dividing the mass into twenty-five pills, one of which may be thrown away. One of the objects in pill-making should be to keep the pill as small as possible, but no pills ought to be sent out weighing *less* than one grain.

After each addition of excipient the mixture is detached from the side of the mortar, and well kneaded until a uniform plastic mass results. Before rolling, the gross weight of the mass should be entered in the prescription book. This practice should never be omitted, as errors in weighing the ingredients may sometimes thus be detected, while it ensures that the pills are always sent out of the same size and weight.

Pill-excipients.—Under this name are comprised all the materials used to bind the ingredients into a mass. In selecting liquid excipients, care must be exercised not to use any that act as complete solvents, nor any powders likely to form insoluble compounds with the ingredients. While not *entirely* dissolving the materials a liquid excipient should possess a modified solvent action, as proof spirit, or else be sufficiently sticky, as glucose, to bind them into a plastic mass. Such excipients require to be added very cautiously, with constant kneading, or the mass will become too soft for rolling. When the first addition is made the mass may appear rather dry and crumbly, but after a few minutes' kneading, owing to the heat generated, it should begin to bind.

To avoid the danger of adding too much excipient at one time, and so making the pills too large or too soft, liquid excipients should be kept

in one-ounce bottles into which a small pipette attached to a rubber ball just dips (fig. 194). By lightly squeezing the ball, as small a quantity as desired may then be dropped upon the ingredients. Dry excipients may be kept in wide-mouthed bottles provided with a perforated cork in which a short piece of quill is inserted (fig. 195).

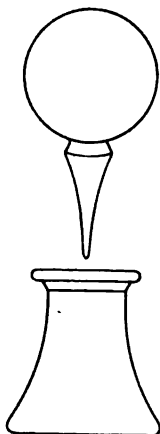


FIG. 194.—EXCIPIENT BOTTLE.



FIG. 195.—EXCIPIENT BOTTLE.

Although special excipients have been recommended from time to time, it is generally found that good dispensers rely on two or three only, with the behaviour of which they are well acquainted.

White powders generally may be made into a mass with compound powder of tragacanth and a little syrup, with glycerin of tragacanth, or with glucanth. Glycerin by itself should be avoided, as pills containing much of it are liable to lose their shape and become sticky through absorption of moisture.

Coloured powders may be massed with any appropriate, physiologically inert, excipient. The most useful powders are liquorice and althæa.

Examples.

Acid, benzoic.—Glucanth or a little tragacanth and simple syrup.

Acid, carbolic.—Carbolic acid in pills may be treated in several ways, one of which is to add one-twentieth the weight of glycerin, afterwards massing with a mixture of wheaten flour eight parts and tragacanth two parts. Another and far better method is to mass with wheaten flour and hard paraffin. If desired the following mass, containing 50 per cent. of phenol, may be kept ready made :

Absolute Phenol	.	.	.	.	.	60	parts
Hard Paraffin	.	.	.	.	.	12	„
Wheaten Flour	.	.	.	.	.	45	„
Glucanth	.	.	.	.	.	3	„

Pills made from this formula readily disintegrate in lukewarm water, and no objection is likely to be raised to the presence of paraffin.

Aloes, Asafetida.—The best excipient for pills containing these in combination with extract of colocynth and similar drugs, is proof spirit. Pills composed of extract of aloes alone should be mixed with one-tenth their weight of powdered althæa and massed with rectified spirit.

Antipyrin, Phenacetin.—With glucanth.

Bismuth carbonate and oxyhydrate.—With glucanth or compound tragacanth powder and syrup.

Calcium sulphide.—Usually ordered in small quantities; should be first mixed with milk-sugar, and then massed with tragacanth and syrup, or glucanth.

Calomel.—Confection of roses has been recommended for massing calomel, but it is better to follow the rule of only using white excipients for white pills. Strained manna, or tragacanth and syrup, answers every purpose.

Camphor is often stated to give trouble. This is true of certain substances which liquefy when rubbed with camphor, as chloral, phenol, etc., but camphor *per se* is not really difficult to manipulate. The secret is to powder the camphor very finely; if then it is mixed with a little starch or wheaten flour, it may be massed with glucanth without trouble. When ordered with extract of henbane or other 'green' extract, the camphor, if powdered finely, frequently forms a very good pill without further addition; but with equal parts of camphor and extract of henbane, the mass is too soft, and should be stiffened with equal parts of tragacanth and wheaten flour.

Creosote.—In the author's opinion, creosote occasions more trouble than camphor when ordered in pills. The best plan is to keep a 50-per-cent. creosote mass ready made, which may be dispensed from as required. The following modification of Martindale's formula gives very good results. To fifty parts of creosote in a wide-mouthed bottle add fifteen parts of melted yellow wax and thirty-five parts of powdered *curd* soap. Cork, and heat on a water-bath, shaking occasionally, until combination takes place. This, when cold, gives a plastic and fairly stiff mass, which only requires the addition of a little powder when dispensing. The use of magnesia for massing is not to be recommended, the pills becoming as hard as marbles and almost as insoluble.

Crystalline salts, such as potassium and ammonium bromide, potassium iodide, etc., should, after powdering very finely, be mixed with one-tenth their weight of tragacanth, and massed with syrupy glucose. Glycerin in any form should never be used.

Extracts, such as 'ergotin' and the 'green' extracts generally, are

not sufficiently firm for making into pills. It is customary, therefore, to evaporate them over a water-bath until sufficiently hardened, making a note on the label of the jar that six parts represent eight parts of the soft extract, or whatever the case may be. In addition, most dispensers keep *powdered* extracts on their shelves, and, provided these have been prepared by evaporation *in vacuo*, there can be no objection to their use. The more common are the powdered extracts of belladonna, nux vomica, henbane, compound extract of colocynth, gentian, taraxacum, etc. If properly prepared these should not have lost any of the characteristic odour during drying, and particularly they should not be hygroscopic.

Iron phosphate.—This is frequently ordered in combination with quinine and strychnine. It is customary to mass with syrupy phosphoric acid (sp. gr. 1.5). The mass should be worked and rolled rapidly, as it sets almost at once.

Iron, reduced.—Powder very finely, mix with one-tenth its weight of tragacanth, and mass with glucanth.

Iron sulphate, dried.—This is best massed with syrup or glucose, taking care to add enough at once, or a crumbly mass results.

Lithium guaiacate.—Powder finely and make into a rather soft mass with rectified spirit. Work up and roll without delay, as the mass hardens very rapidly.

Mercury with chalk.—Hydrarg. c. Cretâ requires very careful manipulation in kneading. If worked too vigorously, or if the mass is made too hard, the mercury separates. Extract of gentian is an excellent excipient. Wheaten flour and glucanth also make a good pill.

Oils, essential.—When considerable quantities of essential oils are ordered in pills, the best results are obtained by massing with a mixture of equal parts of powdered curd soap, calcium phosphate, and wheaten flour. If absolutely necessary, a small proportion of yellow wax may be melted with the oil, but must not exceed one-tenth the weight, or the pills will probably not disintegrate.

Pepsin.—The so-called *insoluble* pepsin does not make good pills, but if a mixture of two parts of insoluble and one part of powdered *soluble* scales is employed, an excellent pill may be made with the help of syrup.

Phosphorus.—When small doses of phosphorus are ordered, it may be possible to use an equivalent quantity of the official mass, but if this would unduly increase the bulk, an equivalent quantity of 10-per-cent. phosphorated suet must be used. Prepare some fresh mutton suet according to the pharmacopœial directions, and allow to cool. Take of—

Phosphorus	.	.	.	.	.	10 grains
Carbon Disulphide	.	.	.	.	.	1 fluid drachm
Suet	.	.	.	.	.	90 grains

Dissolve the phosphorus in the carbon disulphide in a bottle, add a little of the suet, and shake well; then add the remainder, mix thoroughly, allow the disulphide to evaporate, and preserve under water.

This basis contains 10 per cent. of phosphorus.

Potassium permanganate for obvious reasons must not be massed with any readily oxidisable excipient. Very good pills may be made with kaolin ointment, or, if not at hand, with what amounts to the same thing, Unguentum Paraffini B.P. and fullers' earth. Lanolin has also been recommended, as well as resin ointment.

Quinine and iron citrate.—Powder finely, add one-twentieth of powdered tragacanth, and mass with syrup, or with the official Unguentum Paraffini. Many dispensers prefer to moisten the powdered scales with proof spirit, in which case the mass must be kneaded and rolled out as quickly as possible. Under no circumstances must any preparation of glycerin be used.

Quinine sulphate may be massed with glucanth or tragacanth and syrup.

Rhubarb masses readily with syrup and a trace of tragacanth.

Salol is more frequently prescribed in tablets or cachets than in pilular form. It may, however, be made into pills with glucanth. The mass should not be worked too vigorously, as salol melts at about 42° C., and is then somewhat intractable.

Silver nitrate should be finely powdered with white fullers' earth and massed with Unguentum Paraffini B.P. Breadcrumb should never be used, as it not only yields unsatisfactory pills, but contains sodium chloride, with which silver nitrate is incompatible.

Silver oxide.—As for silver nitrate.

Sulphonal, Tetronal, Trional.—As for salol.

Sulphur.—When sulphur is ordered in pills, either alone or with other ingredients, only the 'washed' variety should be used. This, if finely powdered, gives no trouble with the ordinary excipients.

Tar pills are now seldom prescribed, but may be prepared by adding one-fifth the weight of melted yellow wax to the tar in a warm mortar; a mixture of equal parts of lycopodium and wheaten flour should be then incorporated until the mass is sufficiently firm for rolling into pills.

Zinc valerianate, if ordered alone in pills, should be reduced to fine powder, one-twentieth of powdered acacia added, and massed with glucanth. It is, however, frequently prescribed with asafetida and other resins, when the mixed powders only need slightly moistening with rectified spirit to produce an excellent mass.

CLASSIFIED LIST OF EXCIPIENTS

Acacia powder and mucilage. Avoid as much as possible, as pills containing gum become exceedingly hard.

Alcohol for resinous pills.

Althæa in fine powder. Useful as an absorbent; has tendency to make pills somewhat spongy.

Breadcrumb.—Useless.

Calcium phosphate.—Either alone, or mixed with wheaten flour, for essential oils.

Confection of roses has nothing to recommend its use over many other more reliable excipients.

Decoction of aloes, compound.—Useful on account of the carbonate of potassium it contains. May be used for most pills containing aloes. Incompatible with iron salts.

Elm bark in fine powder is used for the same purposes as powdered althæa.

Fullers' earth, Kaolin.—Useful for such pills as potassium permanganate, etc.

Glucanth.—A mixture of—

Tragacanth	$\frac{1}{2}$ ounce
Glycerin	1 $\frac{1}{2}$ ounces
Water	$\frac{1}{2}$ ounce
Syrupy Glucose	3 $\frac{1}{2}$ ounces

This excipient is useful in many instances where glycerin of tragacanth is unsuitable on account of the large proportion of glycerin it contains.

Glycerin, owing to its hygroscopic action, should be avoided as far as possible, especially for pills intended to be silvered or coated with either gelatin or chalk.

Liquorice powder is a most useful general absorbent.

Soap, curd.—Useful in massing oils, creosote, etc.

Tragacanth.—Both the simple and compound powders are invaluable for binding friable, and giving firmness to soft, masses.

Tragacanth, glycerin of.—One of the most generally useful excipients.

Water.—Use sparingly.

Wax.—Use sparingly. See Creosote and Tar pills.

Compound dextrin powder.—

Powdered Tragacanth	1
Powdered Acacia	1
Powdered Dextrin	1
Starch	2

Useful absorbent powder, especially when the mass is disinclined to bind.

Before sending out pills it is customary either to coat them or to add a little dry powder, such as liquorice, lycopodium, starch, or French chalk. By far the most elegant method is to cover the pills with some innocuous and soluble coating, such as sugar or gelatin.

PILL-COATING

Sugar coating.—For extemporaneously coating small quantities of pills with sugar, the following process may be adopted. Moisten the pills slightly but evenly with

Sandarach Pill-varnish	:	.	.	.	.	1 part
Mucilage of Acacia	.	.	.	.	.	2 parts
Simple Syrup	.	.	.	.	.	4 „

and throw into a covered pot containing a mixture of finely powdered sugar seven parts, starch one part. Rotate rapidly for a few seconds, and turn out on to a hair sieve; separate the powder and rotate gently on the sieve until excess of powder has been rubbed off. Now place in another clean warm pot and rotate until perfectly dry. Repeat the operations until the pills have acquired three or four coatings, when they may be left on the sieve to dry.

Gelatin coating is perhaps one of the best methods yet devised for masking the taste and odour of nauseous pills. No expensive apparatus is necessary for its application, while the pills are exposed to undesirable conditions of temperature and moisture for the minimum of time. The coating is, moreover, both soluble and transparent.

The selection of the excipients for massing pills intended to be gelatin-coated requires considerable experience, as it is important that no hygroscopic substance, such as glycerin, is used. The pills should be fairly dry before coating, or they will be found to 'bud.' This is caused by coating damp or soft pills. The gelatin, when it dries, shrinks very considerably and forces some of the mass through the weakest part of the coating. The pills are first shaken in a bag of soft material to free them from adhering powder; they are then impaled on long slender needles, which may be fixed in corks, and dipped in a solution of gelatin kept at a temperature of about 30° C. After withdrawal they are rotated gently while the gelatin sets, and then left to dry. The gelatin solution may be prepared as follows:

Gelatin	.	.	.	.	.	.	2 parts
Water	.	.	.	.	.	.	15 „
Mucilage of Acacia	.	.	.	.	.	.	1 part

Allow the gelatin to soak in the water until softened; dissolve by the heat of a water-bath; add the mucilage, strain, and make up the weight to eighteen parts. A little chloroform may be added as a preservative.

For white pills the solution must be as nearly colourless as possible, but for dark pills a little caramel may be added with advantage.

Figs. 196, 197, and 198 illustrate Niblett's pill-coating apparatus. The first figure shows the pills ready for dipping. The pills are impaled by means of the base or pill-receiver. Each recess accommodates a pill, and as the needles on the dipper correspond in position with these recesses, the pills are taken up simultaneously. Fig. 197 shows the process of dipping. The superfluous gelatin is got rid of after withdrawing the dipper, by lowering it again until the lower side of the pills just touches the surface of the liquid, after



FIG. 196.



FIG. 197.



FIG. 198.

GELATIN PILL-COATING.

which the dipper is lifted out and rotated gently for a few seconds, when it is placed on its side until the pills are dry. Fig. 198 represents the action of expelling the pills from the needles. This is done with a sliding plate actuated by a spring, the whole of the pills being detached at once. After removal from the needles, it is sometimes found, when the pills have been dipped too deeply, that a little gelatin tube projects from each. This should be cut off with a pair of sharp scissors before sending out.

Pearl coating is largely made use of in this country, and if properly done imparts a very pleasing appearance to the pills. The disadvantage is that the coating is insoluble, and cases are not rare where pills so coated have passed unchanged through the system. For coating small quantities extemporaneously at the dispensing counter, the perfectly round and hard pills are varnished with a very thin covering of sandarach or tolu. They are then damped evenly with a mixture of—

Mucilage of Acacia	2 parts
Syrup	2 „

thrown into finely powdered talc, and shaken vigorously for a few moments. After sifting out the excess of powder, the pills are transferred to a perfectly smooth and clean covered pot, or a metal coater similar to fig. 199, and rotated until smooth and fairly dry.



FIG. 199.—HAND COATER.



FIG. 200.—BOXWOOD PILL-SILVERER.

After exposure to the air for a short time a second coat is applied in a manner similar to the first, and if necessary a third. The pills should then be allowed to dry perfectly, when they may be polished by rotating in a clean pot with a ball of hard paraffin.

Silvering.—Covering pills with gold or silver leaf was one of the earliest methods of coating, and silver leaf is still employed for the same purpose. The pills are slightly moistened with very thin acacia mucilage, thrown into a covered pot or wooden coater (fig. 200) containing silver leaf, and rotated vigorously for a minute or so. They are then exposed to the air for a little time to dry, and afterwards burnished by rotating in a second clean pot. As a rule, one leaf of silver suffices for covering one dozen five-grain pills. Pills containing sulphur or sulphides should not be silvered.

Keratin coating is made use of, not so much to give the pills a finished appearance as to protect them during their passage through the stomach—keratin being insoluble in the gastric juice, so that solution of the pill will not take place until the intestine is reached. The process for keratin coating is very tedious, but otherwise presents no special difficulty. The pills, which should be massed with Ung. Paraffini or Ung. Resinæ, are placed in a dish with a little of the keratin solution, and rolled about until evenly coated, when they are

turned on to a porcelain tray and allowed to dry. At least three coatings are required to be of any service. To prevent their sticking together they may be shaken with a trace of finely powdered graphite.

Keratin pill-coating.—

Keratin prepared with pepsin	1 ounce
Solution of Ammonia 0·880	5 fluid ounces
Absolute Alcohol	5 „ „

Dissolve.

Salol has been proposed as a substitute for keratin coating when the pills are not intended for solution in the stomach, but its utility has been questioned. It may be applied by dipping the pills, fixed on needles, into melted salol, allowing to cool, detaching, and closing the needle-holes with a camel-hair pencil dipped in the melted substance.

Varnishing.—For the extemporaneous coating of pills no method has yet been introduced to supersede varnishing, and, with a little care, excellent results are attained with the least expenditure of time. The pills, as for all coating operations, should be round and firm, and free from any adhering powder; they are placed in a covered pot with a few drops of the varnish, well shaken for a few moments, and

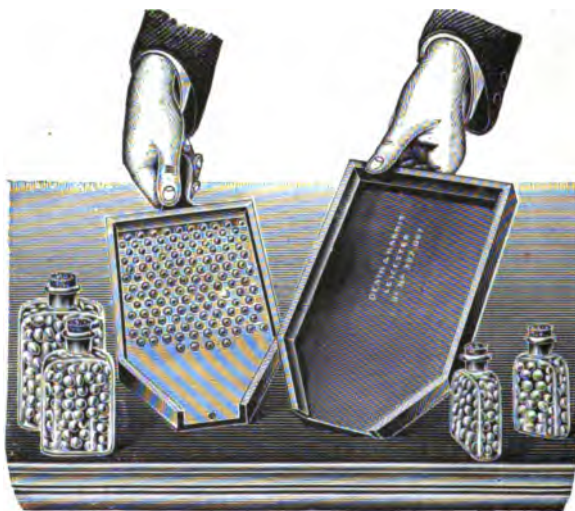


FIG. 201.—PILL OR TABLET COUNTER.

rapidly turned out into a porcelain tray to dry. The most convenient trays for the purpose are the developing dishes used by photographers.

Pill-varnish.—

Sandarach	4½ ounces
Methylated chloroform	4 fluid ounces
Methylated ether, sp. gr. 0·717	10 „ „

Dissolve.

For dark-coloured pills a varnish made by dissolving the residue left in the manufacture of syrup of tolu may be used. The proportions are—

Tolu residue	6 ounces
Methylated ether, sp. gr. 0·717 . . .	8 fluid ounces
Methylated chloroform	4 „ „

Pill-counting.—When pills are required to be counted in considerable quantities, the device shown in fig. 201 is resorted to. Pills are thrown on to the counter, and the apparatus shaken so as to get one pill in each hole, the remainder being allowed to run off. This leaves a gross of pills ready for emptying on to the scoop, by means of which they are transferred to bottles.

CHAPTER XLVI

SUPPOSITORIES

The name *suppository* is given to solid preparations of conical shape intended for the introduction of medicaments into the rectum. Similar preparations for the vagina are known as *pessaries*, while those for the nose and urethra are termed *bougies*. As the usefulness of these preparations is entirely dependent upon their melting completely at the temperature of the body, care must be exercised in the selection of the basis with which they are to be compounded. The bases in most general use are oil of theobroma, and a combination of

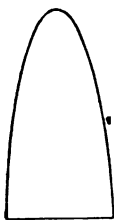


FIG. 202.
RECTAL SUPPOSITORY.

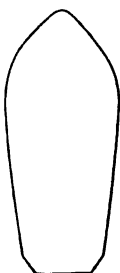


FIG. 203.
RECTAL SUPPOSITORY.



FIG. 204.
NASAL BOUGIE.

gelatin and glycerin; others have been proposed, such as stearin, and a mixture of stearic and oleic acids; while in the 1885 edition of the Pharmacopœia, curd soap massed with glycerin of starch was employed. Of these, oil of theobroma is by far the most useful; although melting below 35° C., it is sufficiently firm to be handled at the ordinary temperature, while its non-irritating nature pre-eminently adapts it for internal application.

The usual shape of rectal and vaginal suppositories is that of a cone with a rounded apex, as fig. 202. Besides this another form has been lately introduced (fig. 203), which is supposed to be more readily retained in the rectum. The weight of rectal suppositories is officially fixed at fifteen grains, although in practice they are often made to exceed it, whilst pessaries vary from thirty to 120 grains. Pencil-shaped bougies



FIG. 205.—SUPPOSITORY-BATH.



FIG. 206.—CAPSULE.



FIG. 207.—TIN SUPPOSITORY-BATH.

for the nose (fig. 204) may weigh about thirty grains, and are usually four inches in length, those for the urethra being a little longer.

The most convenient dishes for melting the ingredients are porcelain capsules with handles, sold by the chemical apparatus makers (fig. 206), although small water-baths of the shapes shown in figs. 205 and 207 are sometimes preferred.



FIG. 208.—BOUGIE-MOULD.



FIG. 209.—PESSARY-MOULD.

Metal moulds stamped fifteen, twenty, thirty, sixty, and one hundred and twenty grains are in common use; these open in different ways, but preference should be given to those opening vertically, so as to expose the whole length of the suppositories (figs. 208 and 209).

The capacity of these moulds varies considerably. White and Braithwaite examined eight sets and found them all too small. Not only did the moulds vary, but the capacities of individual holes were found to be different. To remedy this inaccuracy they suggested that the specific gravity of the block of metal should be taken, and a definite weight of metal drilled out. This weight is ascertained as follows: Average specific gravity of theobroma may be taken as 0.965, and the specific gravity of the metal used for the moulds as 7.60. If, therefore, 118 grains $\left(\frac{7.6 \times 15}{0.965} \right)$ of metal is removed, a cavity

will be left capable of holding fifteen grains of theobroma. A variation of one grain in the weight of metal drilled out only makes about one-tenth grain difference in the theobroma content of the holes.

Moulds already in use should be carefully standardised, and the amount of error noted.

Theobroma suppositories.—These may be considered under three heads :

- (a) Suppositories containing small quantities of medicaments, as alkaloids and their salts.
- (b) Suppositories containing insoluble substances of high gravity, as mercuric oxide, iodoform, etc.
- (c) Suppositories containing extracts.

(a) The suppositories belonging to this class present little difficulty. The theobroma should be cut small and melted at as low a temperature as possible. The medicament, *having been powdered very finely* or dissolved in a few drops of water (in the case of alkaloids use oleic acid), is mixed with a portion of the melted fat on a slab. When the remainder of the fat in the dish shows signs of thickening, the medicated portion is stirred in and the mixture poured into the moulds, stirring being continued all the time.

(b) The theobroma is melted as in (a), and a small quantity poured on to a slab. With this, *the medicament in very fine powder* is thoroughly mixed by means of a flexible spatula. More warm theobroma is added from time to time until about half has been used. The medicated portion is next transferred to the dish and the whole diligently stirred. If the proper degree of heat has been employed, the mixture just before pouring will be of the consistence of thick cream, and will solidify before the suspended powder has time to settle. If the mixing of the two portions has been effected at too high a temperature, the medicament will in all probability separate and be found in a hard lump at the apex of each suppository.

(c) The preparation of suppositories containing extracts is somewhat more difficult, and requires the greatest care in the management of the heat. The theobroma is cut small, melted at a very low temperature, and a portion poured out on a slightly warmed slab. The extract, previously softened by rubbing with a little water or alcohol, according to its nature, is thoroughly mixed with this, the theobroma being added by degrees until a perfect mixture results. This is then transferred to the dish and warmed *very slightly*, stirring the whole time, not being poured into the moulds until it is almost at the point of solidification.

When very large quantities of extracts are introduced, the author suggests the addition of a little gelatin. Thus :

Extract of Henbane	60 grains
Oil of Theobroma	a sufficiency

For twelve suppositories, 15 grains each.

Place the extract in a small dish with three grains of gelatin (previously softened with water) and warm gently. As the gelatin melts, mix, and gradually add the melted but nearly cool theobroma, stirring constantly. The mixture, which should be of a creamy consistence, is then poured into the moulds direct.

When considerable quantities of *liquids* are required to be introduced into theobroma suppositories, as liquid extract of witch hazel, adrenalin solution, etc., there is no better plan than that suggested by Taylor :

When the liquid medicament may be heated without injury, it is boiled with about 2 per cent. of sodium stearate and then allowed to cool. The oil of theobroma is added, and the whole stirred until emulsified.

In the case of liquids injured by great heat, the sodium stearate may be melted with a little water, the medicament incorporated, and finally the oil of theobroma.

General remarks.—As there is always some waste in suppository-making, due to small quantities adhering to the apparatus, it is advisable to make one or two extra, so as to ensure turning out the required number.

To prevent the suppositories adhering to the mould the latter should be lubricated by wiping with a plug of cotton damped with solution of soft soap in alcohol 5 per cent. Only the smallest quantity should be used, or the suppositories, instead of coming out smooth and glossy, will have a mottled appearance.

In hot weather the moulds should be placed in cold water or on a block of ice, so as to ensure rapid solidification.

Stearin suppositories.—Cocoa-nut stearin has been suggested as a basis for suppositories. Its melting-point is considerably lower than that of theobroma, thus rendering it somewhat more difficult to handle in warm weather. It may be used in precisely the same way as theobroma.

Gelatin suppositories.—Gelatin is principally used as a basis for glycerin suppositories,¹ the formula adopted by the Pharmacopœia being as follows :

Gelatin	14 parts by weight
Glycerin	70 " "
Water	16 " "

During evaporation, stir as little as possible to avoid the formation of bubbles. When the mixture has arrived at the correct weight,

¹ Another formula for glycerin suppositories is as follows :

Glycerin	88.20
Sodium Carbonate	4.37
Stearic Acid	7.43

allow to stand for two or three minutes, remove the scum that rises, and pour into slightly oiled moulds.

For the exhibition of other medicaments a formula containing somewhat less glycerin is adopted :

Gelatin	12.50
Glycerin	60.00
Water	27.50

Salts, extracts, and other freely soluble substances are dissolved in a portion of the water, and added to the melted gelatin. Tannic acid requires different and very careful treatment. If dissolved in water and added to the gelatin direct, it causes immediate precipitation. It has, however, been observed by Crinon *that if the tannin is dissolved in the water in which the gelatin is allowed to soak*, no difficulty is experienced so long as the amount does not exceed 7 or 8 per cent., such suppositories readily dissolving in water heated to 35° C.

The gelatin basis for *pessaries* is usually somewhat less firm than that required for suppositories, 10 per cent. more water being added. *Bougies*, on the other hand, require a firmer basis—

Gelatin	18.0
Glycerin	20.0
Water	62.0

Urethral bougies of extra length and rigidity are occasionally prescribed. These are made with the last-mentioned basis, threaded on fine silk, and left to evaporate in a warm place free from dust until of the required consistence. Moulds for bougies six to eight

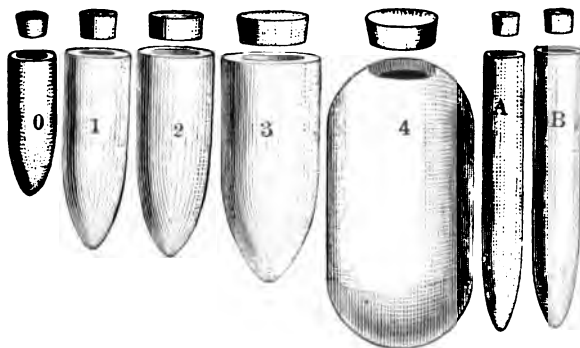


FIG. 210.—HOLLOW CACAO SUPPOSITORIES.

inches long may be made by wrapping tinfoil round a perfectly smooth and tapering penholder, afterwards supporting the shell in a box of *warm* sand. Should any irregularities appear when the foil is stripped, the bougies should be held momentarily in a vessel containing boiling water.

Hollow suppositories.—Shells of theobroma (fig. 210) are sometimes used for the introduction of special medicaments. The drug

must, however, be diluted with grated theobroma before packing into the shells.

Sending out of suppositories.—Suppositories should be sent out in partitioned boxes; failing this, they may be packed in shallow boxes lined with waxed paper. The practice of wrapping them singly in tinfoil is not recommended, as ignorant persons might omit to remove the covering, which, moreover, often adheres in an annoying manner.

Large quantities of suppositories are made by cold compression. Although the finish is not quite so good as when made by casting in moulds, there is great saving of time, and, of course, absence of danger from overheating. In addition, by incorporation in the cold, it is possible to exhibit certain medicaments, such as chloral hydrate,



FIG. 211.—SUPPOSITORY-MACHINE.

which cannot be prepared by melting in the ordinary way. The suppository mass is prepared by kneading in a mortar. For this purpose all solid substances must be reduced to a state of impalpable powder before adding to the oil of theobroma, which is generally used in a coarsely grated condition. The machine shown in fig. 211 is furnished with moulds for making both suppositories and bougies. The medicated mass is placed in the cylinder, a mould attached, and the cylinder fixed in position with the end of the mould resting against the movable plate at the end of the machine. The mass is then compressed by turning the wheel, which screws the plunger into the cylinder. The end plate is next removed, when a further turn of the wheel forces the finished suppositories out upon the tray, the operation being repeated until all the mass has been used.

CHAPTER XLVII

OINTMENTS

The dispensing of ointments may be considered under two heads :
(a) those requiring melting and (b) those which may be mixed in the cold.

(a) Ointments requiring the application of heat generally have for a basis a mixture of oil, lard, or soft paraffin, with some solid of higher melting-point, as beeswax or hard paraffin. The melting of the solid portion does not present any difficulty, but no more heat should be used than is necessary to effect liquefaction. If powders are to be incorporated they should be ground very fine and sifted on to the mixture just when it begins to thicken, and the whole stirred until cold, any volatile ingredient being added towards the end.

On no account should the melted fats be transferred to a cold vessel, or a lumpy ointment, due to sudden solidification of the waxes, will be the result. Generally it is better to effect admixture in the vessel used to melt the ingredients, *but if for any reason it is found necessary to use a mortar, it must first be heated, by means of boiling water, to a point above that at which any portion of the basis will solidify.* If hot water is not at hand and the mortar is not of large size, many dispensers pour in a little alcohol and set light to it, rotating occasionally so as to warm the mortar evenly. The author, however, does not commend this plan, as it sometimes results in breakage.

(b) As a rule most of the ointments prepared at the dispensing counter are made in the cold, from such stock bases as lard, soft paraffin, etc. When the quantity does not greatly exceed one or two ounces it is customary to employ a slab and broad-bladed spatula. Preference should in all cases be given to steel spatulas, bone or vulcanite only being used when the medicaments are likely to have any action on steel. For quantities over two or three ounces a mortar may be used.

Considerable dexterity is required to make an ointment neatly and quickly on a slab, and the student is recommended to practise with inexpensive materials until proficiency is attained. The slab itself should be of good size, certainly not less than twelve inches square; the spatula, which must be flexible, may be about eight inches long in the blade and $1\frac{1}{4}$ or $1\frac{1}{2}$ inches wide. It is used with a regular

side-to-side and not rotary motion, the blade being kept as flat as possible the whole time. The spatula must be cleaned by the aid of another, and not by scraping it against the edge of the slab ; in fact, the ointment should be kept near the middle, and not allowed to work towards the edge at all.

Incorporation of insoluble powders.—To secure a perfectly smooth ointment it is necessary to add powders in a state of minute subdivision, sifting if necessary through a sieve or a piece of muslin stretched over the rim of a large chip-box. In most cases it is advantageous to mix the powders with a small portion of the basis first, the remainder being added by degrees.

Incorporation of crystalline substances.—When the proportion of medicament is very small it is customary to add it to the basis in a state of solution. Not only is a smoother ointment produced by this method, but the drug, especially in the case of alkaloids, is enabled to exert its full effect.

Cocaine hydrochloride, atropine sulphate, and similar salts should be dissolved in the smallest possible quantity of water. Alkaloids may be either dissolved in a little 90-per-cent. alcohol or combined with sufficient oleic acid to effect solution.

Incorporation of extracts.—Ointments containing 10 or even 20 per cent. of vegetable extracts are frequently met with, and are always made in the cold. If the basis has to be specially made by melting, it must be allowed to become nearly cold before mixing with the extract ; if the latter is at all hard or lumpy, it should be softened with a little warm water or alcohol, according to its nature, and added to a portion of the basis a little at a time. Glycerin should never be used to soften hard extracts, whether for ointments or suppositories.

Incorporation of liquids.—Cold cream is an excellent type of an ointment containing a large amount of liquid. The rose-water, which should be warmed to about 33° C., is stirred or whipped in just when the melted fats show signs of congealing. Admixture may be effected in a warm mortar, either by means of a whisk, such as is used for whipping cream, or with an ordinary pestle. It is important not to add the water too quickly or the greater part will separate again as the ointment cools. After all the water has been added, stirring should be continued until the ordinary temperature has been regained, and a perfectly creamy product results.

Ointments containing lanoline will take up a relatively large proportion of water, especially if admixture is effected in a warmed vessel. They possess, however, the disadvantage of turning brown on the surface when exposed to the air, owing to loss of water by evaporation. Tinctures and spirits, such as Liq. Hamamelidis, are often prescribed in ointments ; these may be stirred into almost any basis in the cold, care being taken not to add too much at one time.

CHAPTER XLVIII

PLASTERS

In the preparation of this class of remedies for local application, emollient or stimulating substances are mixed with various medicaments in such proportions that the resulting mixture, although solid at ordinary temperatures, will, when spread in a thin layer on calico, leather, or other material, be rendered adhesive and flexible by the warmth of the body. The Pharmacopœia enumerates a fairly long list of plasters, the greater number of which contain lead plaster as a basis, the other principal basis consisting of a mixture of resins and soap. Of late years plasters of this class have fallen into partial disuse, their place having been taken by adhesive plasters prepared with a rubber basis.

Some plasters are merely intended to afford support to the parts of the body to which they may be applied, while others are medicated so as to act as vesicating, stimulating, or anodyne applications. The spreading of plasters is an operation connected with the dispensing of medicines which requires more skill and experience than most other branches of the art; for this reason the beginner is recommended to practise by spreading some inexpensive plaster, as Emp. Resinæ, on brown paper until a fair amount of dexterity is acquired, when a trial may be made on leather.

Plasters are generally spread on the *rough* side of sheepskin (plaster-leather), but are sometimes required on wash-leather, calico, silk, or swansdown; if the last is employed the plaster is spread on the smooth side. When a plaster is ordered in a prescription, in addition to the name of the principal medicament or pharmacopœial title, the size and shape are usually indicated; occasionally the part is named to which the plaster is to be applied, and the determination of the size and shape left to the judgment of the dispenser. There are certain shapes which are generally adopted for application to particular parts of the body, and, in the absence of specific instructions, the dispenser should conform to the recognised practice in this respect. Thus, fig. 212 represents the form of plaster usually applied to the chest; fig. 213, that for application between the shoulders; fig. 214, that for the small of the back; fig. 215 is the form

adopted for the side ; fig. 216, for applying behind the *left* ear ; fig. 217, for the *right* ear ; fig. 218 represents a breast plaster for women. It will of course be understood that these figures represent the forms, and not the relative sizes, of the respective plasters.

Blisters for applying to the back of the ear are invariably spread on adhesive plaster ; all others, unless otherwise directed, on ordinary

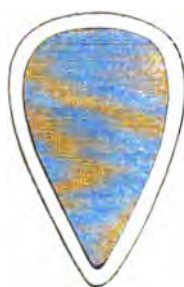


FIG. 212.



FIG. 213.

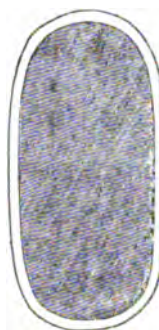


FIG. 214.



FIG. 215.

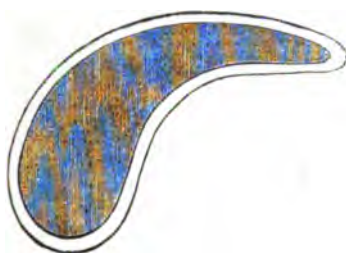


FIG. 216.

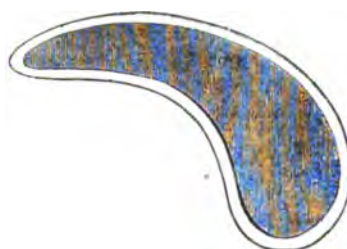


FIG. 217.

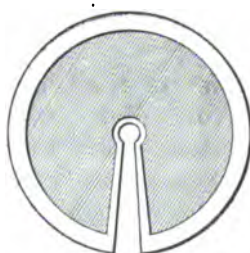


FIG. 218.

white plaster-leather. It is customary to leave a margin of unspread leather around all plasters. For ordinary sizes a margin of one inch is considered sufficient, but for very small plasters the margin may be reduced to half an inch, or even a quarter of an inch.

When about to spread a plaster—say, of belladonna for the small of the back, ten inches by six inches—a piece of leather free from flaws

is selected about three inches larger each way than the specified size. A few sheets of thick brown paper are laid on the counter to prevent the heat being conducted away too rapidly during the operation, and the leather is carefully smoothed by ironing with a moderately hot spatula. To prevent the leather from soiling, it should be protected by a piece of paper whilst being made smooth. If too great a pressure or heat is employed at the beginning, the leather is sure to wrinkle and cockle, when no amount of extra ironing will flatten it out again. The use of the sheet of paper during the ironing process is an extra safeguard, for if too great a heat is used, the paper will show signs of scorching before the leather is much harmed.

Cutting the shape.—The leather having been prepared, a piece of paper—say, fourteen inches by ten inches—is folded equally across its longest diameter, and again across its shortest diameter. Five inches is next measured off (on the quarter-sheet) in the longer direction and three inches in the shorter, and the inside cut out as shown in fig. 219. Very accurate shapes may be cut if a pencil line is first ruled as a guide, the rounded corners being made equal by placing a small coin in the

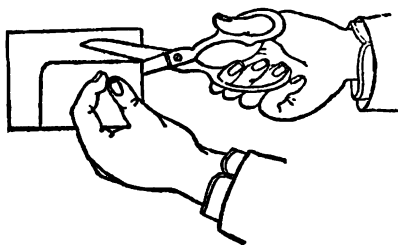


FIG. 219.

angles and drawing the curves around it. The paper margin is then soaked for a few seconds in water, excess of water removed by blotting-paper, and pressed evenly on the leather. The practice of smearing the paper margin with soft soap to make it adhere is not recommended, as the soap discolours the leather.

The next step is to melt the plaster. The time-honoured way was to press the roll of plaster against the hot iron, allowing the melted medicament to collect on a piece of paper, from which, as soon as sufficient had collected, it was transferred to the leather. Experience, however, has taught that it is preferable to take a weighed quantity of plaster (about ten grains to the square inch), and melt it in a porcelain capsule over a Bunsen flame. When completely melted, but not in a state of fluidity, the plaster is quickly transferred to the centre of the leather, and, with as little loss of time as possible, spread evenly over the surface. Spreading should commence from the middle and finish up at the margin, so that when completed the plaster should be of equal thickness in all parts, and the surface even and glossy. If the melted plaster is of the right temperature it will spread easily, and yet not penetrate the leather sufficiently to show through the back. The shape must be removed before the plaster sets, as, once the latter is cold, the paper leaves a broken margin when detached. To avoid accident, especially in the spreading of

large plasters, it is safer to have two heated plaster-irons at hand, so that, if one becomes too cool, the second may be used.

The shape of the spatula or plaster-iron is not of very great importance, the most usual being that shown in fig. 220. Plaster-irons may be heated in an ordinary fire, but preferably in a Bunsen flame, as being less likely to cause injury to the blades. The exact temperature can only be learned by experience. If the application of the iron causes the plaster to smoke, the temperature is much too high. Of late years an improved form of spatula (fig. 221) has come into use, consisting of a hollow iron of the usual shape, provided on its upper surface with a number of small holes. A flexible gas tube is attached to the handle, which is also hollow. The amount of heat can be regulated to a nicety by increasing or decreasing the size of the gas jets, and, in the hands of those accustomed to its use, the apparatus is of great utility.

Plasters with adhesive margins (fig. 222).—Certain plasters which possess little or no sticking power of themselves require the addition



FIG. 220.—PLASTER-IRON.



FIG. 221.—GAS PLASTER-IRON.

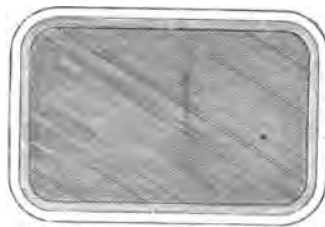


FIG. 222.—PLASTER WITH ADHESIVE MARGIN.

of an adhesive margin to ensure their remaining fixed to the part of the body to which they are applied. Supposing a plaster of this description, six inches by three inches, is required, the usual method of proceeding is as follows: A suitable piece of leather having been selected, a paper shape enclosing a space, say, eight inches by five inches is cut, and made to adhere to the leather by moistening. A little adhesive plaster (*Emp. Resinæ*), having been melted in a small dish, is poured on the leather close to the paper edge, and a margin of about two inches spread all the way round. The paper shape is next removed, and the plaster laid on a cold surface. When sufficiently hard, a second shape, enclosing a space six inches by three inches, is cut from *waxed* paper, and laid on the leather in such a way that an even margin of adhesive plaster is left on each side. The second shape must be sufficiently broad to cover not only the adhesive margin, but the plain leather one. All being ready, the centre of the leather is next spread with the medicated plaster, and the paper stripped off. When the shape is removed it will probably be found that the surface of the

adhesive margin appears somewhat dull where the paper was pressed on to it, but the dulness at once disappears if the finished plaster is passed rapidly, face downwards, over a Bunsen flame.

Breast plasters (fig. 218).—These plasters should be spread on either ‘split skin’ or ‘wash-leather.’ More difficulty will be experienced in spreading a plaster on these than on ordinary sheep-skin, on account of the liability to stretch and pucker. To obviate this tendency, the leather should be first stretched moderately tightly and then tacked down, over several sheets of brown paper, to a piece of smooth board; on no account should the leather be tacked down to the counter or bench, as the position of the leather requires to be constantly varied during the spreading. The melted plaster must not be poured directly on to the leather, but on to a piece of brown paper, and only pushed on to the leather when it begins to cool. In



FIG. 223.

fact, too much care cannot be exercised in regulating the heat both of plaster and iron, as if the temperature is allowed to rise too high, a discoloured plaster will be the result.

Sending out of plasters.—Plasters should be sent out in shallow cardboard boxes, the plaster being fastened down at each end by one of the small brass clips used for securing documents, the ends of the clips being turned back outside the bottom of the box.

Blisters.—Blisters are spread on ordinary adhesive plaster on unglazed calico. Besides those intended for the back of the ear (figs. 216 and 217), square and

circular blisters are frequently prescribed for application to the temple and other parts. Mr. Thompson gives the following hint on cutting shapes for ear blisters: Bend the forefinger of the left hand, and allow it to touch the top of the thumb; the figure formed, will give a fair idea of the proper form of blister for the left ear (fig. 223). If the same is done with the right hand it gives the shape for the right ear. For blisters it is not necessary to leave so wide a margin as for other plasters, an eighth of an inch being ample. The cantharides plaster of the Pharmacopœia partakes more of the nature of a cerate than of a plaster, and can be easily spread by means of a flexible knife, particularly if it has been rubbed down on a slab previous to spreading. Some dispensers are in the habit of sprinkling blisters with finely powdered cantharides, others of painting the blister with

Liquor Epispasticus, with the idea of increasing the vesicating action, but such practices are not warranted.

Court plaster consists of fine silk coated with isinglass. It may be prepared by dissolving two ounces of isinglass in sixteen ounces of distilled water by the aid of a water-bath, adding by degrees, when nearly cold, twelve ounces of rectified spirit. The silk, having been evenly stretched on a frame, is painted over with this solution, the operation being repeated when dry, until five or six coats have been laid on or the film appears of sufficient thickness. The silk used for this purpose may be either black, white, or flesh-coloured.

Rubber plasters.—Plasters containing a rubber basis have been in use for a number of years, and for certain purposes are a great advance on those hitherto considered. Their preparation unfortunately cannot conveniently be undertaken by the retail pharmacist on account of the expensive nature of the apparatus required, and the large quantities necessarily dealt with. The following gives some idea of the process :

Rubber (Para)	.	.	.	.	.	.	.	2 parts
Burgundy Pitch	.	.	.	.	.	.	.	1 part
Olibanum	.	.	.	.	.	.	.	1 „

The crude rubber is washed and softened by kneading in a stream of warm water, finally leaving the machine in thin sheets. These sheets are dried, and crushed between rollers until they become plastic and soft. The next operation consists in kneading in the resins, which is accomplished by means of another pair of rollers, the upper roller of which revolves faster than the lower. When thoroughly mixed the medicaments are added, and after incorporation the whole is spread on fabric, also by means of heavy rollers.

These plasters do not require warming to make them adhere, the temperature of the body being quite sufficient. For ordinary binding and strapping purposes rubber plasters are probably of great service, but it remains to be proved that as a means of exhibiting medicament they offer any advantage over those prepared according to the Pharmacopœia.

PART V



TESTS AND TABLES

CHAPTER XLIX

TESTS FOR SUBSTANCES MENTIONED IN THE TEXT OF THE PHARMACOPŒIA, WITH EXPLANATIONS OF THE MORE IMPORTANT REACTIONS

Acetates.—1. Acetic acid and acetic ether possess characteristic odours.

2. All the acetates are soluble in water; the neutral or faintly acid solution affords a deep red coloration (ferric acetate) with ferric chloride, which on boiling deposits a reddish-brown precipitate (ferric oxyacetate). The red colour due to the formation of ferric acetate is not discharged by mercuric chloride solution; it turns yellow on the addition of hydrochloric acid.

3. Acetates warmed with sulphuric acid evolve the odour of acetic acid; warmed with sulphuric acid and a little ethylic alcohol, ethyl acetate is formed.

4. When dry acetates are heated gradually, they yield acetone:



5. When heated with a caustic alkali they yield methane:

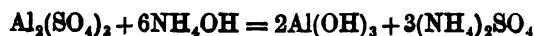


6. When heated with arsenious anhydride they yield cacodyl oxide (dimethylarsine oxide):



Cacodyl oxide has an intensely obnoxious smell, and is exceedingly poisonous, consequently very minute quantities should be used in performing this test.

Aluminium.—Both ammonium hydrate solution and ammonium hydrosulphide solution afford a white gelatinous precipitate of aluminium hydrate:



Freshly precipitated aluminium hydrate is soluble in hydrochloric acid, in acetic acid, and in solution of potassium hydroxide,

but nearly insoluble in solution of ammonia, and quite insoluble if the solution is boiled.

Ammonium salts.—1. Ammonium salts volatilise when strongly heated. Benzoate, bromide, carbonate, and chloride leave no residue, but *sublime* unchanged. Ammonium phosphate when strongly heated leaves a residue of meta-phosphoric acid. The nitrate decomposes into nitrous oxide and water :



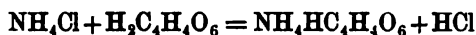
Ammonium nitrite yields nitrogen and water :



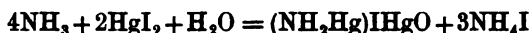
2. When heated with solution of potassium or sodium hydroxide, all salts of ammonia yield ammonia gas, recognised by its odour, and a glass rod dipped in hydrochloric acid, held over the test-tube in which the operation is performed, produces white fumes of ammonium chloride.

3. Solution of platinic chloride affords with ammonium salts acidified with hydrochloric acid a yellow crystalline precipitate of the double chloride of platinum and ammonium, $\text{PtCl}_4 \cdot 2\text{NH}_4\text{Cl}$. If the solution is very dilute, a little alcohol should be added. The double salt on ignition leaves a residue of metallic platinum.

4. A concentrated solution of tartaric acid produces in concentrated solutions of ammonium salts a white crystalline precipitate of acid tartrate of ammonium, especially in the presence of alcohol :



5. Alkaline solution of potassio-mercuric iodide (Nessler's solution) affords a brown precipitate of oxy-dimercuric ammonium iodide :



In *very* dilute solutions a coloration ranging from reddish brown to yellow is produced.

Antimony.—1. Hydrogen sulphide in slightly acid solutions yields an orange-coloured precipitate of amorphous antimonious sulphide, Sb_2S_3 . This precipitate has the same composition as the crystalline black sulphide, into which it is converted on drying and exposing to heat. The moist precipitate dissolves in solution of potassium hydroxide, forming potassium antimonite, K_3SbO_3 , and thioantimonite; in solution of ammonium hydrosulphide, forming ammonium thioantimonite $(\text{NH}_4)_3\text{SbS}_3$. It also dissolves in warm strong hydrochloric acid, evolving hydrogen sulphide, leaving antimonious chloride, SbCl_3 , in solution (distinction from arsenic).

Antimonious sulphide is almost insoluble in solution of the official ammonium carbonate, and in solution of acid potassium sulphite.

2. Antimony compounds, when placed in a Marsh's apparatus (fig. 224) with dilute hydrochloric acid and some fragments of zinc, suffer decomposition, the antimony coming off as hydrogen antimonide. If the evolved gases are burnt at the jet, antimony oxide, Sb_2O_3 , is formed, but if a cold porcelain tile is held in the flame a stain of metallic antimony forms, which is *not* appreciably dissolved by solution of chlorinated soda (distinction from arsenic).

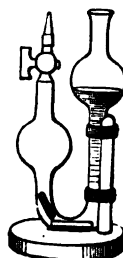
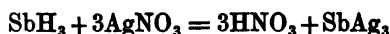


FIG. 224.
MARSH'S
APPARATUS.

3. When hydrogen antimonide, SbH_3 , is led into solution of silver nitrate, a black precipitate of metallic silver and antimony is formed; and on the cautious addition of ammonium hydroxide to the supernatant liquid it causes no yellow precipitate (distinction from arsenic):



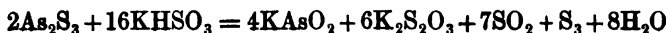
4. If one end of a strip of pure zinc is allowed to rest on the edge of a bright platinum capsule, containing an acidified antimony solution, the other end being in the liquid, hydrogen antimonide is *not* evolved, but the antimony is precipitated on the platinum as a black, adherent non-granular stain, insoluble in hydrochloric acid (distinction from tin).

5. Reinch's test (see Arsenic) produces a black coating of metallic antimony on bright copper-foil, which, if gently dried and heated in a glass tube, sublimes and condenses *close* to the copper as the white *amorphous* trioxide, Sb_2O_3 . This sublimate is insoluble in water, but readily dissolves in a boiling solution of acid tartrate of potassium.

Arsenic.—1. Hydrogen sulphide, after acidulation with hydrochloric acid, affords a yellow precipitate of arsenious sulphide, As_2S_3 ; arsenious sulphide may be regarded as a thioanhydride, as it gives rise to a series of salts known as thioarsenites, or sulpharsenites. Thus, when arsenic trisulphide is added to a solution of a caustic alkali, such as potassium hydroxide, the sulphide readily dissolves, with the formation of arsenite and thioarsenite:



2. The yellow precipitate is also soluble in the official solution of ammonium carbonate, forming ammonium thioarsenite, $(\text{NH}_4)_3\text{AsS}_3$, also in a hot solution of hydrogen potassium sulphite (distinction from the sulphides of Sb, Sn, Au, and Pt), forming metarsenite and thiosulphite, thus:



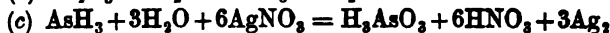
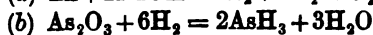
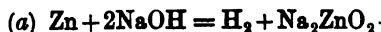
From these solutions arsenic trisulphide is again precipitated on heating with hydrochloric acid—in contradistinction to antimony.

3. Arsenic compounds, when introduced into a Marsh's apparatus (see Antimony) with dilute hydrochloric acid and some fragments of zinc, suffer decomposition, the arsenic coming off as hydrogen arsenide. If the evolved gases are ignited at the jet, As_2O_3 is formed, but if a cold porcelain tile is held in the flame a stain of metallic arsenic forms, readily dissolved in solution of chlorinated soda (distinction from antimony).

4. When hydrogen arsenide, AsH_3 , is led into solution of silver nitrate a black precipitate of metallic silver is produced; and the cautious addition of ammonium hydroxide to the supernatant liquid causes a yellow precipitate of silver arsenite, Ag_3AsO_3 .

5. If a few fragments of zinc are boiled with solution of potassium hydroxide and an arsenical compound added, hydrogen arsenide is given off, and is detected by the black stain produced on a cap of white filtering-paper, moistened with silver-nitrate solution, placed over the mouth of the test-tube (Fleitmann's test).

In this reaction hydrogen arsenide is formed, which reduces the silver nitrate, forming arsenious and nitric acids and liberating metallic silver :



NOTE.—Fleitmann's test does not react with antimony compounds at all.

6. Stannous chloride dissolved in a large excess of hydrochloric acid gives, on boiling with arsenical compounds, a brownish-black precipitate of metallic arsenic, the stannous chloride being oxidised to the stannic salt at the same time. This test (Bettendorff's) cannot be applied in the presence of much water or of nitrates. It is very useful for detecting arsenic in hydrochloric or sulphuric acid, or in tartar emetic.

7. If an arsenical solution is acidulated with hydrochloric acid and boiled with a strip of bright copper-foil, a grey coating of cupric arsenide is deposited. On drying the copper, cutting into fragments, and heating in a wide glass tube, a *crystalline* sublimate of As_2O_3 is formed *at some distance* from the heated portion. On examining under a lens the sublimate is seen to consist of characteristic octahedral crystals (compare Antimony).

8. *Arsenites*.—These yield a yellow precipitate of argentic arsenite, Ag_3AsO_3 , with solution of silver ammonio-nitrate.

Arsenates.—These yield a chocolate-coloured precipitate of silver arsenate, Ag_3AsO_4 , with solution of silver ammonio-nitrate.

Solution of ammonio-magnesium sulphate yields a white crystalline precipitate.

Bismuth.—1. Hydrogen sulphide affords a brownish-black precipitate of bismuth sulphide, Bi_2S_3 ; it differs from the sulphides of arsenic and antimony in not being soluble in the alkaline hydrates or sulphides. It is also insoluble in solution of potassium cyanide and in dilute hydrochloric acid. It is decomposed and dissolved by boiling nitric acid.

2. Solution of potassium hydroxide, sodium hydroxide, or ammonia (except in the presence of citrates, etc.) yields a white precipitate of hydrated bismuthous oxide, $\text{Bi}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$, insoluble in excess, and becoming converted into the monohydrate on boiling, $\text{Bi}_2\text{O}_3 \cdot \text{H}_2\text{O}$.

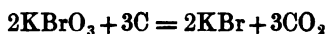
3. When a neutral or nearly neutral solution of a bismuth salt is poured into a large excess of dilute solution of sodium chloride, a white precipitate of bismuth oxychloride, BiOCl , is formed, which is insoluble in tartaric acid (distinction from antimony oxychloride).

4. Solution of neutral potassium chromate gives a yellow precipitate of bismuth oxychromate, $\text{Bi}_2\text{O}_3 \cdot \text{CrO}_4$, soluble in dilute nitric acid, insoluble in solution of potassium hydroxide (distinction from lead chromate).

NOTE.—Bismuth salts are not precipitated by dilute sulphuric acid.

Bromates.—1. Sulphurous acid liberates bromine from bromates, recognised by its odour and appearance; on adding a few drops of chloroform it dissolves the liberated bromine, and sinks to the bottom of the test-tube as a brown globule.

2. After ignition with charcoal, bromates are converted into bromides, and the latter yield the characteristic reactions (see Bromides):



Bromides or hydrobromides.—1. All the bromides are soluble in water with the exception of the silver, lead, and mercurous salts.

2. Solution of silver nitrate gives a yellowish curdy precipitate of silver bromide, AgBr , readily soluble in solution of potassium cyanide to form a double cyanide of silver and potassium. Silver bromide is slightly soluble in strong, but almost insoluble in weak solution of ammonia, and quite insoluble in nitric acid.

3. Solution of sodium nitrite acidified with dilute hydrochloric acid does not liberate bromine from a bromide (distinction from iodides).

4. Solution of chlorine liberates bromine from bromides, and if a few drops of chloroform are shaken up with the mixture, a brownish-coloured globule containing the bromine settles at the bottom of the tube when allowed to rest. Care must be taken not to have the chlorine in great excess, or colourless bromine trichloride may form.

5. Bromine is liberated when a bromide is heated with sulphuric acid and an oxidiser, such as manganese dioxide, lead peroxide, or

potassium dichromate, and the liberated vapour gives an orange-yellow colour to white filter-paper soaked in mucilage of starch. The sulphuric acid first forms hydrobromic acid, and on the addition of an oxidising agent bromine is set free, thus :



NOTE.—When testing for bromides in iodides, all iodine should first be removed by boiling the aqueous solution with excess of lead peroxide.

Cadmium.—1. Hydrogen sulphide yields a yellow precipitate of cadmium sulphide, CdS , insoluble in weak cold dilute hydrochloric acid; insoluble in solution of ammonium hydrosulphide or potassium hydroxide (distinction from the somewhat similar precipitates of arsenic, antimony, or tin sulphides); insoluble in solution of potassium cyanide (distinction from copper); soluble in nitric acid, hot diluted sulphuric acid, and hot diluted hydrochloric acid.

2. Solution of potassium or sodium hydroxide affords a white precipitate of cadmium hydrate, $\text{Cd}(\text{OH})_2$, insoluble in excess (distinction from zinc).

3. Solution of ammonia gives a white precipitate of cadmium hydrate, $\text{Cd}(\text{OH})_2$, readily soluble in excess.

Calcium.—1. Solution of ammonium carbonate yields a white precipitate of calcium carbonate, CaCO_3 , insoluble in solution of ammonium chloride (distinction from magnesium).

2. Solution of ammonium oxalate gives a white precipitate of calcium oxalate, CaC_2O_4 , soluble in hydrochloric acid, but insoluble in acetic acid.

3. Solution of potassium chromate ($\text{K}_2\text{Cr}_2\text{O}_7$) gives no precipitate (distinction from barium).

Carbonates and bicarbonates.—1. Dilute acids cause an effervescence of carbon dioxide, which is *odourless*, and passed into lime-water gives a white precipitate of CaCO_3 .

2. Soluble carbonates afford a brownish-red precipitate of mercuric oxide, with mercuric chloride. Bicarbonates (when pure) yield a white opalescence, but if the test-tube is violently shaken and slightly warmed the precipitate becomes more decided and of a brownish tinge. This is caused by loss of carbonic anhydride, the normal carbonate then precipitating mercuric oxide.

3. Soluble carbonates yield a white precipitate with solution of magnesium sulphate in the cold; bicarbonates do not. That is to say, magnesium carbonate is an insoluble, magnesium bicarbonate a soluble salt.

Chlorides or hydrochlorides.—1. Solution of silver nitrate affords a white curdy precipitate of silver chloride, AgCl , soluble in solution

of ammonia, but insoluble in nitric acid. Silver chloride dissolves in potassium cyanide solution to form a double cyanide of potassium and silver.

2. A solid chloride when subjected to distillation with sulphuric acid and potassium dichromate yields a reddish-brown distillate of chromyl chloride, CrO_2Cl_2 , which is decomposed by water into chromium trioxide and hydrochloric acid. The resulting solution when nearly neutralised with solution of ammonia gives a yellow precipitate of lead chromate, PbCrO_4 , with solution of lead acetate; and a mixed red and white precipitate of silver chromate, Ag_2CrO_4 , and silver chloride, AgCl , with solution of silver nitrate. The red precipitate is dissolved by nitric acid, and both precipitates by solution of ammonia.

3. Heated with manganese dioxide and sulphuric acid, chlorides yield chlorine, recognised by giving a blue colour with solution of potassium iodide and mucilage of starch.

Citrates.—1. Heated alone, citrates slowly char, evolving at the same time a faint odour of burnt sugar. At a dull red heat the citrates of potassium, sodium, and lithium become converted into carbonates.

2. Solution of calcium chloride added in excess affords, *when boiled* with a neutral solution of a citrate, a white precipitate of calcium citrate, $\text{Ca}_3(\text{C}_6\text{H}_5\text{O}_7)_2$, insoluble in solution of potassium hydroxide, but soluble in solution of ammonium chloride and in solution of alkaline citrates.

3. Solution of nitrate of silver causes, in solutions of neutral citrates, a white precipitate soluble in ammonia. A mirror is not formed on the sides of the tube when the ammoniacal solution is heated (distinction from tartrates).

Copper.—1. Hydrogen sulphide or ammonium hydrosulphide yields in solutions which are not strongly acid, a brownish-black precipitate of cupric sulphide, CuS ; cupric sulphide is insoluble in dilute hydrochloric acid and in solution of potassium hydroxide, *almost* insoluble in ammonium hydrosulphide; it is dissolved by boiling nitric acid, and when *freshly precipitated*, by solution of potassium cyanide.

2. Solution of potassium hydroxide gives a bulky light-blue precipitate of cupric hydrate, $\text{Cu}(\text{OH})_2$, which is decomposed upon boiling into brownish-black cupric oxyhydrate, $(\text{CuO})_2\text{Cu}(\text{OH})_2$. Cupric hydrate is soluble in a very large excess of a concentrated solution of potassium hydroxide, forming a blue solution.

3. In the presence of neutral tartrates and citrates the light-blue precipitate of cupric hydrate redissolves almost as soon as formed, yielding a deep-blue solution, which is not affected by heat.

4. If a little dextrose be mixed with solution of potassium hydroxide and then with a soluble cupric salt, a similar deep-blue solution is obtained, but when warmed it deposits a bright-red precipitate of cuprous oxide, Cu_2O , the solution becoming colourless if sufficient dextrose has been added.

5. Solution of ammonia or ammonium carbonate added in small quantity to a neutral solution of a copper salt gives a greenish-blue precipitate, which readily dissolves in excess of solution of ammonia, forming a deep-blue solution, containing—in the case of cupric sulphate—tetrammonio-cupric sulphate, $(\text{NH}_3)_4\text{CuSO}_4 \cdot \text{H}_2\text{O}$. This blue coloration is perceptible in exceedingly dilute solutions.

6. Solution of potassium ferrocyanide gives a reddish-brown precipitate of cupric ferrocyanide, $\text{Cu}_2\text{FeC}_6\text{N}_6$, or in very dilute solutions a reddish-brown coloration, unaffected by dilute acids, but decomposed by alkaline liquids.

7. Bright steel, such as the blade of a knife, receives a reddish coating of metallic copper when placed in a solution of a copper salt.

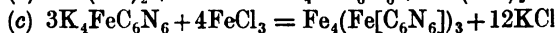
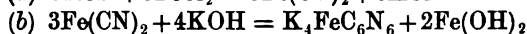
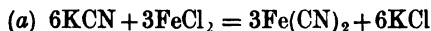
Cyanides.—1. Solution of silver nitrate affords a curdy white precipitate of silver cyanide, AgCN , soluble in solution of potassium cyanide, forming the double salt, $\text{KCN} \cdot \text{AgCN}$. Silver cyanide is also soluble in boiling concentrated nitric acid, and moderately soluble in solution of ammonia.

2. If to a soluble cyanide be added a few drops of a mixed solution of ferrous and ferric salts, then of solution of potassium hydroxide, and lastly excess of hydrochloric acid, a precipitate of Prussian blue results, $\text{Fe}_4(\text{Fe}[\text{C}_6\text{N}_6])_3$. The explanation of this test is as follows :

(a) The addition of the ferrous salt produces ferrous cyanide.

(b) This reacting with excess of alkali produces potassium ferrocyanide.

(c) On the addition of the ferric salt it is first precipitated by the excess of alkali as ferric hydrate, which on acidulation dissolves to ferric chloride, forming ferric ferrocyanide or Prussian blue, thus :



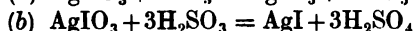
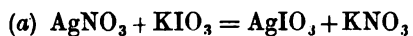
3. When insoluble cyanides are heated in a dry tube they decompose and yield cyanogen, C_2N_2 , which burns with a characteristic peach-coloured flame.

Hydrobromides.—See Bromides.

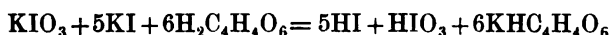
Hydrochlorides.—See Chlorides.

Iodates.—1. Solution of silver nitrate gives a white crystalline precipitate of silver iodate, sparingly soluble in water and in dilute

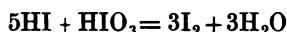
nitric acid, but readily dissolved by solution of ammonia. Sulphurous acid, when added to the ammoniacal solution, gives a pale yellow precipitate of silver iodide :



2. A mixed solution of potassium iodide and a soluble iodate with tartaric acid liberates iodine, which yields a blue colour with mucilage of starch. When excess of tartaric acid is added to an iodate, iodic acid is set free ; and when the same acid is added to an iodide, hydriodic acid is formed :

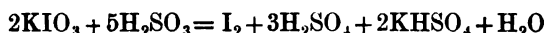


The hydriodic acid, being a reducing agent, at once acts on the iodic acid, iodine being set free and water formed :



3. Solution of barium chloride gives a white precipitate, nearly insoluble in water and soluble with difficulty in diluted nitric acid.

4. On the addition of mucilage of starch and sulphurous acid a blue colour is produced :



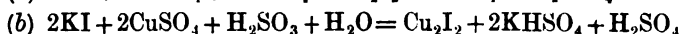
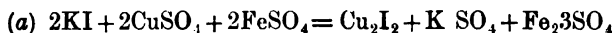
Iodides.—1. Solution of silver nitrate affords a curdy yellow precipitate of silver iodide, insoluble in nitric acid, almost insoluble in solution of ammonia, but dissolving in solution of potassium cyanide to form a double cyanide of potassium and silver.

2. Solution of mercurous nitrate produces a green precipitate of mercurous iodide, HgI , insoluble in diluted nitric acid, but soluble in solution of potassium iodide.

3. Solution of mercuric chloride yields a scarlet precipitate of mercuric iodide, HgI_2 , slightly soluble in excess of the mercuric chloride, and very soluble in potassium iodide solution.

4. Solution of lead acetate causes a yellow precipitate of lead iodide, PbI_2 , soluble in diluted nitric acid, and in boiling water. From the latter lead iodide separates in golden scales as the solution cools.

5. Solution of copper sulphate mixed with a solution of ferrous sulphate, or with sulphurous acid, affords with neutral solutions a whitish precipitate of cuprous iodide, Cu_2I_2 , soluble in solution of ammonia and slightly soluble in hydrochloric acid :



This test is especially valuable, as it distinguishes iodides from

both chlorides and bromides, neither of which are precipitated by this treatment.

6. A small quantity of chlorine or bromine, preferably added in aqueous solution, liberates iodine from iodides.

Solution of sodium nitrite and dilute hydrochloric acid also act in a similar manner. If only a very small amount of iodine is set free it may either be detected by the intense blue colour it produces with starch mucilage in the cold, or the iodine may be dissolved out by shaking with carbon disulphide, to which it communicates a characteristic violet colour.

Iron.—Reactions common to both ferrous and ferric salts.—1. Solution of ammonium hydrosulphide yields in neutral solutions a black precipitate of ferrous sulphide, FeS , soluble in cold diluted hydrochloric acid with evolution of hydrogen sulphide.

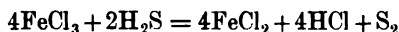
2. Solution of potassium ferrocyanide gives with ferric salts a precipitate of Prussian blue, or with ferrous salts a white precipitate, rapidly turning blue, of Everett's salt—potassium ferrous ferrocyanide, $\text{K}_2\text{Fe}.\text{FeC}_6\text{N}_6$. Both precipitates are insoluble in dilute hydrochloric acid, and both are decomposed by solution of potassium hydroxide.

Reactions characteristic of ferrous salts.—1. Hydrogen sulphide does not cause any precipitate in slightly acid solutions.

2. Solution of potassium ferricyanide affords a dark-blue precipitate of Turnbull's blue, ferrous ferricyanide, $\text{Fe}_3\text{Fe}_2\text{C}_{12}\text{N}_{12}$, insoluble in dilute hydrochloric acid, but decomposed by solution of potassium hydroxide. (Ferric salts give a reddish coloration with this reagent, but no precipitate.)

3. Ferrous salts mixed with solution of potassium hydroxide give a dull green precipitate of ferrous hydrate, $\text{Fe}(\text{OH})_2$. Alkalies are incomplete precipitants of ferrous salts, as the hydrate is slightly soluble in excess of the reagent.

Reactions characteristic of ferric salts.—1. Ferric salts are not precipitated by hydrogen sulphide, but if the gas be passed for some time through a solution containing a ferric salt, a white precipitate of sulphur is thrown down, the following reaction taking place :



The iron is reduced to the ferrous state, and remains in solution in the hydrochloric acid, while the sulphur is precipitated.

2. Solution of ammonium thiocyanate, $(\text{NH}_4)\text{SCN}$, produces a blood-red coloration due to the formation of ferric thiocyanate, $2\text{Fe}(\text{CNS})_3.3\text{H}_2\text{O}$. The red colour is discharged on addition of solution of mercuric chloride (distinction from ferric meconate), but it is not discharged by hydrochloric acid (distinction from ferric acetate).

3. Solution of tannic acid yields a bluish-black coloration or precipitate of tannate with ferric salts, and more slowly with ferrous salts.

4. Solutions of potassium, sodium, or ammonium hydroxide cause a reddish-brown precipitate of ferric hydrate, soluble in solution of citric or tartaric acid. Ferric hydrate is not precipitated in presence of citrates or tartrates (see *Ferri et Quininae Citras*).

Lead.—1. Hydrochloric acid affords, except in very weak solutions, a white precipitate of lead chloride, soluble in boiling water. The aqueous solution as it cools deposits the salt in crystalline form.

2. Hydrogen sulphide, in not very strongly acid solutions, yields a black precipitate of lead sulphide, insoluble in solution of potassium hydroxide and in solution of ammonium hydrosulphide. Lead sulphide is decomposed by boiling with diluted nitric acid, being partly converted into soluble lead nitrate, and partly into insoluble lead sulphate with free sulphur.

3. Diluted sulphuric acid causes a white precipitate of lead sulphate, PbSO_4 , almost insoluble in water, and rendered still less soluble by the addition of dilute sulphuric acid or alcohol, but readily soluble in solutions of ammoniacal salts, especially the acetate.

4. Solution of potassium chromate produces a dense orange-coloured precipitate of lead chromate, PbCrO_4 , which changes to bright red basic chromate, Pb_2CrO_5 , on boiling with solution of potassium hydroxide, and redissolving, when heated with excess of the latter reagent, to form a pale lemon-coloured solution.

5. Solution of potassium hydroxide causes a white precipitate of lead hydrate, dissolving in excess of the reagent to form potassium plumbite, K_2PbO_2 . This compound shows that lead possesses, although to a feeble extent, the acidic properties exhibited by other members of the same group of elements.

Magnesium.—1. Solution of ammonium carbonate produces a white precipitate of magnesium carbonate, dissolving in strong solution of ammonium chloride to form a double chloride of ammonium and magnesium. If the ammonium chloride solution is added first, no precipitate is thrown down.

2. Solution of sodium phosphate, Na_2HPO_4 , in the presence of ammonium chloride and solution of ammonia, yields a white crystalline precipitate of ammonio-magnesium phosphate, MgNH_4PO_4 . In very dilute solutions the precipitate only forms after violent shaking, or rubbing the inside of the test-tube with a glass rod.

3. It is well known that the arsenates are isomorphous with the phosphates, and if ammonium arsenate, $(\text{NH}_4)_2\text{HAsO}_4$, is employed in the reaction described in No. 2 in place of sodium phosphate,

a crystalline precipitate of ammonio-magnesium arsenate forms ($\text{MgNH}_4\text{AsO}_4$).

4. Solutions of the hydroxides of potassium, sodium, ammonium, barium, or calcium produce a white precipitate of magnesium hydrate, $\text{Mg}(\text{OH})_2$, insoluble in excess of the reagent, but readily soluble in solution of ammonium chloride.

Mercury.—Reactions common to mercurous and mercuric salts.—

1. Hydrogen sulphide yields a black precipitate of mercury sulphide, insoluble in ammonium hydrosulphide or in hot diluted nitric acid.

2. Copper-foil immersed in a solution not containing *excess* of nitric acid becomes coated with a deposit of mercury, which on rubbing becomes bright, and from which the mercury may be volatilised and obtained in globules by heating in a dry test-tube.

3. Solution of stannous chloride, SnCl_2 , reduces mercury salts to metallic mercury. Mercuric salts are first reduced to the mercurous state, and these reacting with more of the reagent cause a metallic deposit.

*Reactions characteristic of mercurous salts.—*1. Hydrochloric acid affords a white precipitate of mercurous chloride, Hg_2Cl_2 , turning to black mercurous amido-chloride, $\text{NH}_2\text{Hg}_2\text{Cl}$, on the addition of solution of ammonia.

2. Solution of potassium hydroxide produces a black precipitate of mercurous oxide, Hg_2O , and solution of ammonia a black precipitate of a mercurous amido-salt similar in constitution to that formed in test No. 1.

3. Solution of potassium iodide gives a green precipitate of mercurous iodide, Hg_2I_2 , soluble in excess of the reagent.

*Reactions characteristic of mercuric salts.—*1. Solution of ammonia affords a white precipitate of a mercuric amido-salt, of which the official 'white precipitate' is an example, NH_2HgCl .

2. Solution of potassium hydroxide yields a yellow precipitate of mercuric oxide, HgO .

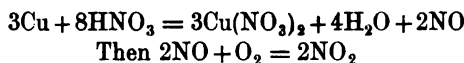
3. Solution of potassium iodide produces a scarlet precipitate of mercuric iodide, HgI_2 , soluble in excess of either the reagent or the mercuric salt. When the precipitate of mercuric iodide first forms it has a distinct yellowish tinge, but rapidly turns scarlet.

*Nitrates.—*1. If a few drops of a solution containing a nitrate are mixed with a solution of ferrous sulphate, and then strong sulphuric acid is cautiously poured down the side of the test-tube, held in a sloping position, so as to fall to the bottom without mixing with the solution, a brown-coloured ring is formed at the junction of the two liquids. The sulphuric acid acting upon the nitrate liberates nitric acid; this is reduced by the ferrous sulphate to nitric oxide, NO , which dissolving in the ferrous sulphate forms an unstable compound

of ferrous sulphate and nitric oxide, $2\text{FeSO}_4 \cdot \text{NO}$. On warming, the colour disappears, nitric oxide being evolved, thus :



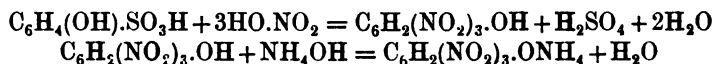
2. Nitrates liberate red fumes when warmed with sulphuric acid and metallic copper, thus :



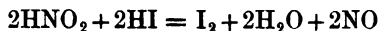
3. The following is not included in the pharmacopœial tests for the presence of nitrates, but it is nevertheless one of the most delicate, and distinguishes, moreover, between nitrates and nitrites :

Prepare some phenol-sulphonic acid, $\text{C}_6\text{H}_4(\text{OH})\cdot\text{SO}_3\text{H}$, by dissolving one part of crystallised phenol in four parts of strong sulphuric acid, and dilute with two parts of distilled water. A small quantity of a solution of a nitrate is evaporated to dryness in a clean porcelain capsule over a water-bath, two or three drops of phenol-sulphonic acid added, well stirred, and heated again for five minutes. On cooling, dilute solution of ammonia is added until faintly alkaline, when a bright yellow solution results.

The excess of sulphuric acid in the reagent liberates nitric acid, which reacts with the phenol-sulphonic acid to form picric acid, $\text{C}_6\text{H}_2(\text{NO}_2)_3\cdot\text{OH}$, and this on the addition of solution of ammonia yields yellow ammonium picrate, $\text{C}_6\text{H}_2(\text{NO}_2)_3\cdot\text{ONH}_4$:



Nitrites.—1. On the addition of a few drops of diluted sulphuric acid with potassium iodide and mucilage of starch, a deep-blue colour is at once formed. The sulphuric acid liberates nitrous acid from the nitrite, and hydriodic acid from the iodide, and these two reacting yield nitric oxide and free iodine, thus :



2. Dilute sulphuric acid liberates red fumes without the presence of metallic copper.

3. Nitrites give a dark-brown coloration with ferrous sulphate on the addition of a *weak* acid. (Compare Nitrates.)

Oxalates.—1. Solution of calcium chloride affords a white precipitate of calcium oxalate, CaC_2O_4 , soluble in hydrochloric, but insoluble in acetic acid.

2. Solution of silver nitrate yields a white precipitate, soluble in solution of ammonia and in dilute nitric acid.

3. Most oxalates are converted into carbonates on igniting.

Oxalates do not char at all when heated with strong sulphuric acid, but decompose with evolution of carbon monoxide, CO, and carbon dioxide, CO₂.

4. Oxalic acid on warming discharges the colour of potassium permanganate acidulated with dilute sulphuric acid. Oxalic acid also decomposes cupric sulphate, liberating sulphuric acid. (The instances in which a sulphate is decomposed by another acidulous radical are extremely rare.)

Phosphates.—1. Solution of ammonio-nitrate of silver yields a light yellow precipitate of silver phosphate, Ag₃PO₄, soluble both in solution of ammonia and in cold dilute nitric acid.

2. Solution of ferric chloride in the presence of ammonium acetate or other neutral acetate yields a whitish precipitate of ferric phosphate, FePO₄, which is insoluble in acetic acid.

3. 'Magnesia mixture' (ammonio-magnesium sulphate) affords a white crystalline precipitate of ammonio-magnesium phosphate, MgNH₄PO₄, soluble in dilute acids. In dilute solutions the precipitate appears slowly, or only after vigorous shaking. Rubbing the sides of the test-tube with a glass rod often induces precipitation when other methods fail.

4. A *large excess* of solution of ammonium molybdate in strong nitric acid produces on warming a yellow precipitate of ammonium phospho-molybdate, 2(NH₃)₃PO₄.22MoO₃.12H₂O. This compound is insoluble in dilute mineral acids, but dissolves in excess of alkalis, phosphates, or phosphoric acid.

Potassium.—1. Solution of 'platinic chloride,' PtCl₄, affords with moderately strong solutions of potassium chloride (or with other potassium salts if free hydrochloric acid is present) a yellow crystalline precipitate of potassium-platinic chloride, insoluble in alcohol, PtCl₄.2KCl, which upon ignition leaves a residue of potassium chloride and platinum. The formation of this double chloride will be understood when it is remembered that in solution of hydrochloric acid, platinum forms a double compound of platinum and hydrochloric acid, PtCl₄.2HCl, to which the name of chloroplatinic acid has been given, and the double salts of platinic chloride and various chlorides are regarded as salts of this acid.

2. Potassium compounds when moistened with hydrochloric acid communicate a violet colour to a colourless Bunsen flame when introduced on a loop of perfectly clean platinum wire.

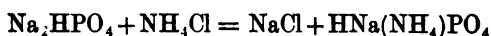
Selenium and Tellurium.—1. Compounds of selenium and tellurium are only to be looked for in bismuth or its preparations.

2. To detect either element in bismuth, dissolve the metal in nitric acid, add to the liquid solution of ammonium chloride, and dilute freely with water. This precipitates bismuth oxychloride. The

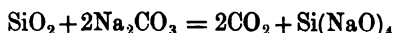
filtrate from the above reaction is then mixed with excess of sodium sulphite, when, if even a trace of either element is present, a reddish or grey-coloured powder is precipitated after standing for about twelve hours. Both selenium and tellurium are objectionable impurities.

Silica.—1. Silica, SiO_2 , after exposure to a red heat is insoluble in all acids with the exception of hydrofluoric. It is not dissolved in a bead of 'microcosmic salt' when heated to fusion in a blow-pipe flame.

Microcosmic salt, hydrogen - sodium - ammonium phosphate, $\text{HNa}(\text{NH}_4)\text{PO}_4$, is obtained by adding a strong solution of common sodium phosphate, Na_2HPO_4 , to solution of ammonium chloride :



2. Silicon dioxide is soluble in a hot solution of the alkalis, and in boiling solution of sodium carbonate. Fused with sodium carbonate, silicon dioxide is converted into soluble sodium silicate :



Silver.—1. Hydrochloric acid and other soluble chlorides afford a white curdy precipitate of silver chloride, AgCl , instantly soluble in solution of ammonia, but insoluble in nitric acid. Silver chloride is also soluble in solution of potassium cyanide.

Sodium.—1. Sodium compounds when moistened with hydrochloric acid communicate a persistent yellow coloration when introduced on platinum wire into the colourless flame of a Bunsen burner.

NOTE.—Platinic chloride forms a double chloride of platinum and sodium, but the compound is soluble in both alcohol and water (distinction from potassium).

There are no characteristic reactions which can be applied for the detection of sodium, but if a solution gives no precipitate with any of the group reagents, but leaves on evaporation a fixed residue capable of imparting a strong yellow colour to a Bunsen flame, it is almost certain that sodium is present.

Starch.—1. When starch is boiled with water a mucilaginous liquid results, which on cooling turns a deep-blue colour with solution of iodine.

2. Boiled for some time with dilute hydrochloric acid and then neutralised with sodium hydroxide, a red precipitate of cuprous oxide is formed on warming with solution of potassio-cupric tartrate (Fehling's solution).

On boiling with dilute acids, starch is first converted into dextrin, $\text{C}_6\text{H}_{12}\text{O}_6$, and on further boiling, into glucose :



Sulphates.—1. Solution of barium chloride affords a white precipitate of barium sulphate, insoluble in hydrochloric acid.

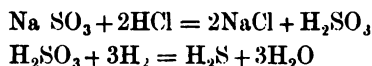
2. Heated with a little sodium carbonate on charcoal, in the inner (reducing) blowpipe flame, sulphates are reduced to sulphides; and the residue, placed on a clean silver coin and moistened with water, leaves a black stain of silver sulphide.

Sulphides.—1. The official sulphides, hydrosulphides, and sulphurated compounds evolve hydrogen sulphide when boiled with strong hydrochloric acid. Hydrogen sulphide is recognised both by its disagreeable smell and by the fact that a slip of white filter-paper moistened with solution of lead acetate is rapidly blackened by the formation of lead sulphide.

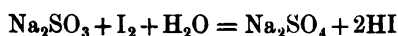
NOTE.—Sulphonal and thiocyanates do not evolve hydrogen sulphide when heated with an acid. If fused with sodium carbonate mixed with a small proportion of potassium nitrate, they afford a mass which, when extracted with water, answers to the tests for sulphates.

Sulphites.—1. Hydrochloric acid liberates sulphurous anhydride, SO_2 , a colourless gas with a pungent smell, without deposition of sulphur (distinction from thiosulphates).

2. When sulphites are acted on by zinc and hydrochloric acid they evolve hydrogen sulphide. In this reaction the excess of hydrochloric acid liberates sulphurous acid from sulphites, which is then attacked by the nascent hydrogen, forming hydrogen sulphide and water, thus:



3. Sulphites decolourise solution of iodine according to the equation—



Tartrates.—1. Tartrates on the application of heat char very readily, giving off the odour of burnt sugar, leaving the base as either carbonate or oxide.

2. Solution of calcium chloride added in excess to a *neutral* tartrate affords a white granular precipitate of calcium tartrate, soluble when freshly precipitated in cold moderately concentrated solution of potassium hydroxide, from which solution it is again precipitated on boiling.

NOTE.—If the precipitate of calcium tartrate is separated by filtration and washed with a little water, it dissolves quite readily in solution of potassium hydroxide. Calcium tartrate is also soluble in tartaric acid.

3. Solution of silver nitrate affords a white precipitate of silver tartrate, soluble in solution of ammonia and in nitric acid. If the ammoniacal solution is gently heated in a perfectly clean test-tube,

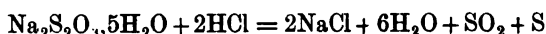
a mirror of metallic silver is formed on the sides of the tube (distinction from citrates). Silver tartrate is soluble in solution of ammonia, but on heating the mixture blackens, owing to the formation of silver oxide; and this under the influence of heat gives off oxygen, leaving metallic silver, which deposits as a mirror on the glass.

4. A concentrated solution of potassium acetate gives a white precipitate of hydrogen-potassium tartrate in moderately concentrated solutions when acidulated with acetic acid and well stirred. If the solutions are very dilute, a large proportion of 90-per-cent. alcohol should be added:



Tellurium.—See Selenium.

Thiosulphates.—1. Hydrochloric acid decomposes thiosulphates, precipitating sulphur and liberating sulphurous anhydride:

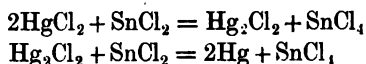


2. When thiosulphates are acted upon by hydrochloric acid and zinc, hydrogen sulphide is liberated.

3. Thiosulphates decolourise solution of iodine, sodium tetrathionate and sodium iodide being formed.

Tin.—1. Metallic zinc placed in a solution of a salt of tin acidified with hydrochloric acid precipitates the tin in metallic scales, or in the form of a grey spongy mass.

2. Metallic tin separated in the preceding is soluble in boiling concentrated hydrochloric acid, and the solution, which contains stannous chloride, SnCl_2 , gives with solution of mercuric chloride a white precipitate of calomel, Hg_2Cl_2 , which becomes grey from separation of globules of mercury if excess of tin salt is present, thus:



Zinc.—1. Solution of ammonium hydrosulphide gives a white precipitate of zinc sulphide, ZnS , soluble in dilute hydrochloric acid, but insoluble in acetic acid.

2. In alkaline solutions the same result is produced by hydrogen sulphide.

3. Solution of potassium hydroxide affords a white precipitate of zinc hydrate, $\text{Zn}(\text{OH})_2$, soluble in excess to form potassium zincate.

4. Solution of potassium ferrocyanide produces a gelatinous white precipitate of zinc ferrocyanide, $\text{Zn}_2\text{FeC}_6\text{N}_6$, insoluble in dilute hydrochloric acid.

NOTE.—Magnesium salts are not precipitated either by ammonium hydrosulphide or by potassium ferrocyanide, so that either of these reagents serves to distinguish zinc sulphate from magnesium sulphate, with which it is isomorphous.

CHAPTER L

Table of the More Potent Vegetable Substances, with their Preparations, Strengths, and Doses¹

Name	Preparations	Strength	Dose	
			Apothecaries' Denomination	Metric Denomination (approximate)
Aconiti Radix . . .	Tinctura Aconiti . . .	5 pts. in 100 fl. pts. . .	5-15 m	0.3 - 1.0 c.c.
Belladonnæ Folia . .	Linimentum Aconiti . . .	2 " in 3 " . . .	1-1 gr.	0.015- 0.06 Gm.
" Radix . . .	Extractum Belladonnæ Viride . . .	" . . .	5-15 m	0.3 - 1.0 c.c.
" . . .	Succus Belladonnæ . . .	" . . .	" . . .	" . . .
" . . .	Extractum Belladonnæ Liquidum . . .	0.75 pt. total alkaloid in 100 fl. pts. .	1-1 gr.	0.015- 0.06 Gm.
" . . .	" " Alcoholicum . . .	1.00 " " 100 fl. pts. .	" . . .	" . . .
" . . .	Linimentum " . . .	0.385 " " 100 " . . .	5-15 m	0.3 - 1.0 c.c.
" . . .	Tinctura " . . .	0.1 " " 100 " . . .	" . . .	" . . .
" . . .	Emplastrum " . . .	0.5 " " 100 " . . .	" . . .	" . . .
Cannabis Indica . .	Extractum Cannabis Indicæ . . .	" . . .	1-1 gr.	0.015- 0.06 Gm.
Colchici Cornus . .	Tinctura " " . . .	5 pts. of the extract in 100 fl. pts. .	5-15 m	0.3 - 1.0 c.c.
" Semina . . .	Extractum Colchici . . .	" . . .	1-1 gr.	0.015- 0.06 Gm.
Digitalis Folia . .	Vinum " . . .	20 pts. in 100 fl. pts. .	5-15 m	0.3 - 1.0 c.c.
" . . .	Tinctura " . . .	20 " in 100 " . . .	10-30 m	0.6 - 2.0 c.c.
" . . .	Infusum Digitalis . . .	3 grs. in 1 fl. ounce . . .	5-15 m	0.3 - 1.0 "
Ergota . . .	Tinctura " . . .	12.5 pts. in 100 fl. pts. .	2-4 fl. drachms	7.0 - 14.0 "
" . . .	Extractum Ergotæ . . .	" . . .	5-15 m	0.3 - 1.0 "
" . . .	" " Liquidum . . .	1 pt. in 1 fl. pt. . .	2-8 grs.	0.1 - 0.5 Gm.
" . . .	Infusum " . . .	5 pts. in 100 fl. pts. .	10-30 m	0.6 - 2.0 c.c.
Gelsemii Radix . .	Tinctura Ergotæ Ammoniata . . .	25 " in 100 " . . .	1-2 fl. ounces	25.0 - 50.0 "
" . . .	" Gelsemii . . .	10 " in 100 " . . .	1-1 fl. drachm	2.0 - 3.5 "
Ipecacuanhæ Radix .	Extractum Ipecacuanhæ Liquidum . .	2 pts. total alkaloids in 100 fl. pts. .	5-15 m	0.3 - 1.0 "
" . . .	Acetum " . . .	0.1 pt. " 100 " . . .	1-2 m	0.03 - 0.1 "
" . . .	" . . .	" . . .	10-30 m	0.6 - 2.0 "

Lobelia	Tinctura Lobeliae Ætherea	20 pts. in 100 fl. pts.	5-15 m	0.3 - 1.0 c.c.
Nucis Vomicae Semina	Extractum Nucis Vomicae	5 pts. of strychnia in 100 pts.	1-1 gr.	0.015-0.06 Gm.
	" " Liquidum	1.5 " 100 fl. pts.	1-3 m	0.06 - 0.2 c.c.
Opium, in powder	Tinctura Nucis Vomicae	0.25 pt. 100 "	5-15 m	0.3 - 1.0 "
	" " " "	Contains when dry 10 per cent. of anhydrous morphia	1-2 grs.	0.03 - 0.1 Gm.
	Emplastrum Opii	Contains 1 pt. of morphia in 100 pts.	1-1 gr.	0.015-0.06 "
	Extractum " "	20 pts. 100 "	5-30 m	0.3 - 2.0 c.c.
	" " Liquidum	0.75 pt. 100 fl. pts.		
	Linimentum " "	0.375 " 100 "		
	Tinctura " "	0.75 " 100 "	5-15 m	0.3 - 1.0 "
	" " Ammoniata.	0.10 " 100 "	1-1 fl. drachm	2.0 - 3.5 "
	" Camphoræ Composita	0.05 " 100 "		2.0 - 3.5 "
	Pilula Ipecacuanhæ cum Scillâ	0.50 " 100 pts.	4-8 gr.	0.25 - 0.5 Gm.
	" Plumbi cum Opio	1.25 " 100 "	2-4 "	0.1 - 0.25 "
	" Saponis Composita	2.0 " 100 "	2-4 "	0.1 - 0.25 "
	Pulvis Cretæ Aromaticus cum Opio	0.25 " 100 "	10-40 "	0.6 - 2.5 "
	" Ipecacuanhæ Compositus	1.00 " 100 "	5-15 "	0.3 - 1.0 "
	" Kino Compositus	0.50 " 100 "	5-20 "	0.3 - 1.2 "
	" Opii	0.10 " 100 "	2-10 "	0.1 - 0.6 "
	Unguentum Gallæ cum Opio	0.75 " "		
	Suppositoria Plumbi Composita	1 gr. of opium in each	1-1 gr.	0.015-0.06 "
Physostigmatis Semina	Extractum Physostigmatis			
Podophylli Resina	Tinctura Podophylli	2 grs. in 1 fl. drachm	1-1 "	0.015-0.06 "
Stramonii Folia	" Stramonii	20 pts. in 100 fl. pts.	5-15 m	0.3 - 1.0 c.c.
" Semina	Extractum "		1-1 gr.	0.015-0.06 Gm.
Strophanthus Semina	" Strophanthi		1-1 "	0.015-0.06 "
	Tinctura "	2.5 pts. in 100 fl. pts.	5-15 m	0.3 - 1.0 c.c.

¹ 1 grain equals approximately 64 milligrammes (0.064 gramme), or 1 milligramme equals $\frac{1}{16}$ grain.

Table of the More Potent Chemical Substances, with their Preparations, Strengths, and Doses ¹

Pharmacopœial Name	Dose		Preparations	Strength		Dose
	Apothecaries' Denomination	Metric Denomination (approximate)		Metric Denomination	Apothecaries' Denomination	
Acetanilidum . . .	1- 3 gr.	0.06 -0.2 Gm.	Liquor Arsenicalis . . .	1 pt. in 100 fl. pts.	2-8 m	0.1 - 0.5 c.c.
Acid. Arseniosum . . .	$\frac{1}{10}$ - $\frac{1}{15}$ "	0.001 -0.004 "	" Arsenici Hydrochloricus . . .	1 " in 100 "	2-8 m	0.1 - 0.5 "
" Carbolieum . . .	1- 3 "	0.06 -0.2 "	Acid. Carbolieum Liquidum . . .	90.9 pts. in 100 pts.	1-3 m	0.06 - 0.2 "
" Hydrocyanic. Dil. . .	2- 6 m	0.1 -0.4 c.c.	Glycerinum Acidi Carbolici . . .	20 " in 100 "		
Amyl Nitris . . .	2- 5 m	0.1 -0.3 "	Suppositoria " " . . .	1 gr. in each		
Antimonii Oxidum . . .	1- 2 gr.	0.06 -0.1 Gm.	Unguentum " " . . .	4 pts. in 100 pts.		
" Tartaratum . . .	$\frac{1}{24}$ - $\frac{1}{2}$ "	0.002 -0.008 "	Tr. Chloroformi et Morphine . . .	5 " in 100 fl. pts. of the diluted acid	5-15 m	0.3 - 1.0 c.c.
" " . . .	1- 2 "	0.06 -0.1 "	by inhalation			
Apomorphinæ Hydrochl. . .	as an emetic		Pulvis Antimonialis . . .	33.3 pts. in 100 pts.	3-6 gr.	0.2 - 0.4 Gm.
Argentii Nitras . . .	$\frac{1}{10}$ - $\frac{1}{2}$ gr.	0.005 -0.002 "	Vinum Antimoniale . . .	0.45 " 100 fl. pts.	10-30 m	0.6 - 2.0 c.c.
" Oxidum . . .	$\frac{1}{4}$ - $\frac{1}{2}$ "	0.015 -0.03 "	" " " . . .	—	2-4 fl. dr.	7.0 -14.0 "
Arsenii Iodidum . . .	1- 2 "	0.06 -0.1 "	Injectio Apomorphinæ Hydrochlor. . .	1 pt. in 100 fl. pts.	5-10 m	0.3 - 0.6 "
Atropina . . .	$\frac{1}{10}$ - $\frac{1}{2}$ "	0.003 -0.01 "	Argentii Nitras Induratus . . .	95 pts. in 100 pts.	by injection	
Atropinæ Sulphas . . .	$\frac{1}{20}$ - $\frac{1}{100}$ "	0.0003 -0.0006 "	" " Mitigatus . . .	33 $\frac{1}{2}$ " in 100 "		
Butyl Chloral Hydras . . .	5- 20 "	0.3 -1.2 "	Liq. Arsenii et Hydrargyri Iodidi . . .	1 pt. in 100 fl. pts.	5-20 m	0.3 - 1.2 c.c.
Chloral Hydras . . .	5- 20 "	0.3 -1.2 "	Unguentum Atropinæ . . .	2 pts. in 100 pts.	$\frac{1}{2}$ -1 m	0.03 - 0.06 "
Chloroformum . . .	1- 5 m	0.06 -0.3 c.c.	Liquor Atropinæ Sulphatis . . .	1 pt. in 100 fl. pts.		
Cocainæ Hydrochloridum . . .	$\frac{1}{2}$ - $\frac{1}{4}$ gr.	0.01 -0.03 Gm.	Lamellæ Atropinæ . . .	$\frac{1}{500}$ gr. in each.		
Codeina . . .	$\frac{1}{2}$ - 2 "	0.01 -0.1 "	Syrupus Chloral . . .	18.25 pts. in 100 fl. pts.	1-2 fl. dr.	3.5 - 7.0 "
Codeinæ Phosphas . . .	$\frac{1}{4}$ - 2 "	0.01 -0.1 "	Aqua Chloroformi . . .	0.25 vol. in 100 vols.	5-20 m	0.3 - 1.2 "
Crescotum . . .	1- 5 m	0.06 -0.3 c.c.	Spiritus " " . . .	5 " in 100 "		
			Linimentum Chloroformi . . .	50 " in 100 "		
			Tinct. Chlorof. et Morphine . . .	7.5 " in 100 "	5-15 m	0.3 - 1.0 "
			Injectio Cocainæ Hypodermica . . .	10 pts. in 100 fl. pts.	2-5 m	0.1 - 0.3 "
			Lamellæ Cocainæ Hydrochloridi . . .	$\frac{1}{10}$ gr. in each	by injection	
			Syrupus Codeinæ . . .	$\frac{1}{2}$ gr. in 1 fl. dr.	$\frac{1}{2}$ -2 fl. dr.	2.0 - 8.0 "

CHAPTER LI

VOLUMETRIC SOLUTIONS AND COEFFICIENTS

Fehling's Solution

A. *Copper Solution* :

Recrystallised Cupric Sulphate	34.67 grammes
Distilled Water to produce	500 c.c.

B. *Alkaline Tartrate Solution* :

Recrystallised Sodium and Potassium Tartrate	173 grammes
Potassium Hydroxide	75 "
Distilled Water to make	500 c.c.

For use, mix equal volumes of the two solutions at the time required.

1 c.c. of the mixed solution is the equivalent of

	Gramme
Cupric Sulphate, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	0.03467
Cupric Tartrate, $\text{CuC}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}$	0.03688
Cane Sugar (inverted)	0.00475
Glucose, anhydrous, $\text{C}_6\text{H}_{12}\text{O}_6$	0.00500
Milk Sugar, anhydrous, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$	0.00678
Starch	0.0045
Maltose	0.00807
$\text{CuO} \times \left\{ \begin{array}{l} 0.4535 \text{ Invert Sugar} \\ 0.4308 \text{ Sucrose after inversion} \\ 0.6153 \text{ Lactose} \\ 0.7314 \text{ Maltose} \\ 0.4927 \text{ Starch} \end{array} \right.$	

Seminormal Hydrochloric Acid Volumetric Solution

(18.09 grammes HCl in 1,000 c.c.)

1 c.c. $\frac{N}{2}$ HCl is the equivalent of

	Gramme
Hydrochloric Acid absolute, HCl	0.01809
Benzaldehyde, $\text{C}_7\text{H}_6\text{O}$	0.0526
Cinnamic Aldehyde, $\text{C}_9\text{H}_8\text{O}$	0.0333
Citral, $\text{C}_{10}\text{H}_{16}\text{O}$	0.03802
Potassium Acetate, $\text{KC}_2\text{H}_3\text{O}_2$ (after ignition)	0.04872
Potassium Bicarbonate, KHCO_3	0.049705
Potassium Bitartrate, $\text{KHC}_4\text{H}_4\text{O}_6$ (after ignition)	0.09339
Potassium Carbonate, anhydrous, K_2CO_3	0.034318
Potassium Citrate, crystallised, $\text{K}_3\text{C}_6\text{H}_5\text{O}_7 + \text{H}_2\text{O}$ (after ignition)	0.05368
Potassium Hydroxide, KOH	0.02787
Potassium Sodium Tartrate, $\text{KNaC}_4\text{H}_4\text{O}_6 + 4\text{H}_2\text{O}$ (after ignition)	0.070045
Sodium Acetate, $\text{NaC}_2\text{H}_3\text{O}_2 + 3\text{H}_2\text{O}$ (after ignition)	0.06755
Sodium Benzoate, $\text{NaC}_7\text{H}_5\text{O}_2$ (after ignition)	0.071505
Sodium Bicarbonate, NaHCO_3	0.041715
Sodium Carbonate, anhydrous, Na_2CO_3	0.026328
Sodium Carbonate, monohydrated, $\text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$	0.030798
Sodium Citrate, $2\text{Na}_3\text{C}_6\text{H}_5\text{O}_7 + 11\text{H}_2\text{O}$ (after ignition)	0.0591
Sodium Hydroxide, NaOH	0.01988
Sodium Salicylate, $\text{NaC}_7\text{H}_5\text{O}_3$ (after ignition)	0.079445

Decinormal Oxalic Acid Volumetric Solution(6.255 grammes $H_2C_2O_4 \cdot 2H_2O$ in 1,000 c.c.)1 c.c. $\frac{N}{10}$ Oxalic Acid is the equivalent of

	Gramme
Oxalic Acid, crystallised, $H_2C_2O_4 \cdot 2H_2O$	0.006255
Ammonia Gas, NH_3	0.001693
Calcium Hydroxide, $Ca(OH)_2$	0.003678
Lead Subacetate, $Pb_2O(C_2H_3O_2)_2$	0.0135935
Manganese Dioxide, precipitated, MnO_2	0.004318
Potassium Hydroxide, KOH	0.005574
Potassium Permanganate, $KMnO_4$	0.0031396
Sodium Hydroxide, $NaOH$	0.003976

Normal Potassium Hydroxide Volumetric Solution(55.74 grammes KOH in 1,000 c.c.)1 c.c. $\frac{N}{1}$ KOH is the equivalent of

	Gramme
Potassium Hydroxide, KOH	0.005574
Acetic Acid, absolute, $HC_2H_3O_2$	0.05958
Ammonia Gas, NH_3	0.01693
Ammonium Chloride, NH_4Cl	0.05311
Boric Acid, H_3BO_3	0.06154
Citric Acid, crystallised, $H_3C_6H_5O_7 + H_2O$	0.06950
Hydriodic Acid, absolute, HI	0.12690
Hydrobromic Acid, absolute, HBr	0.08036
Hydrochloric Acid, absolute, HCl	0.03618
Hypophosphorous Acid, HPH_2O_2	0.06553
Lactic Acid, absolute, $HC_3H_5O_3$	0.08937
Nitric Acid, absolute, HNO_3	0.06257
Oxalic Acid, crystallised, $H_2C_2O_4 \cdot 2H_2O$	0.06255
Phosphoric Acid, H_3PO_4 (to form K_2HPO_4 , with phenolphthalein)	0.048645
Potassium Dichromate, $K_2Cr_2O_7$	0.14614
Sodium Hydroxide, $NaOH$	0.03976
Sulphuric Acid, absolute, H_2SO_4	0.048675
Tartaric Acid, crystallised, $H_2C_4H_4O_6$	0.07446
Trichloroacetic Acid, CCl_3COOH	0.16212

Decinormal Potassium Permanganate Volumetric Solution(3.1396 grammes $KMnO_4$ in 1,000 c.c.)1 c.c. $\frac{N}{10}$ $KMnO_4$ is equivalent to

	Gramme
Potassium Permanganate, $KMnO_4$	0.0031396
Calcium Oxide, CaO (as Oxalate)	0.002784
Iron, Fe (in ferrous compounds)	0.005560
Ferrous Carbonate, $FeCO_3$	0.011505
Ferrous Oxide, FeO	0.007138
Ferrous Sulphate, anhydrous, $FeSO_4$	0.015085
Ferrous Sulphate, crystals, $FeSO_4 + 7H_2O$	0.027601
Ferrous Sulphate, dried, $2FeSO_4 + 3H_2O$	0.017767
Hydrogen Dioxide, H_2O_2	0.001688
Oxalic Acid, crystallised, $H_2C_2O_4 \cdot 2H_2O$	0.006255
Oxygen, O	0.000794
Sodium Nitrite, $NaNO_2$	0.0034285

Decinormal Sodium Chloride Volumetric Solution(5.806 grammes $NaCl$ in 1,000 c.c.)1 c.c. $\frac{N}{10}$ $NaCl$ is the equivalent of

	Gramme
Sodium Chloride, $NaCl$	0.005806
Silver, Ag	0.010712
Silver Nitrate, $AgNO_3$	0.016869
Silver Oxide, Ag_2O	0.011506

370 TESTS FOR PHARMACOPŒIAL SUBSTANCES

Normal Sulphuric Acid Volumetric Solution

(48·675 grammes H_2SO_4 in 1,000 c.c.)

1 c.c. $\frac{N}{1}$ H_2SO_4 is the equivalent of

	Gramme
Sulphuric Acid, absolute, H_2SO_4	0·048675
Ammonia Gas, NH_3	0·01693
Ammonium Carbonate, $(NH_4)_2CO_3$	0·047705
Ammonium Carbonate B.P., $NH_4HCO_3, NH_4NH_2CO_3$	0·052003
Calcium Hydroxide, $Ca(OH)_2$	0·03678
Lead Acetate, crystallised, $Pb(C_2H_3O_2)_2 + 3H_2O$	0·188075
Lead Subacetate, assumed as $Pb_2O(C_2H_3O_2)_2$	0·135935
Lithium Carbonate, Li_2CO_3	0·036755
Magnesium Carbonate $(MgCO_3), (MgOH)_2 + 5H_2O$	0·048226
Magnesium Oxide, MgO	0·02003
Potassium Acetate, $KC_2H_3O_2$ (after ignition)	0·09744
Potassium Bicarbonate, $KHCO_3$	0·09941
Potassium Bitartrate, $KHC_4H_4O_6$ (after ignition)	0·18678
Potassium Carbonate, anhydrous, K_2CO_3	0·068635
Potassium Citrate, crystallised, $K_3C_6H_5O_7 + H_2O$ (after ignition)	0·10736
Potassium Hydroxide, KOH	0·05574
Potassium Sodium Tartrate, $KNaC_4H_4O_6 + 4H_2O$ (after ignition)	0·14009
Sodium Acetate, $NaC_2H_3O_2 + 3H_2O$ (after ignition)	0·13510
Sodium Benzoate, $NaC_7H_5O_2$ (after ignition)	0·14301
Sodium Bicarbonate, $NaHCO_3$	0·08343
Sodium Borate, crystallised, $Na_2B_4O_7 + 10H_2O$	0·18966
Sodium Hydroxide, $NaOH$	0·03976
Sodium Salicylate, $NaC_7H_5O_3$ (after ignition)	0·15889
Zinc Oxide, ZnO	0·04039

Fiftieth-Normal Sulphuric Acid Volumetric Solution

(0·9735 gramme H_2SO_4 in 1,000 c.c.)

1 c.c. $\frac{N}{50}$ H_2SO_4 is the equivalent of

	Gramme
Sulphuric Acid, absolute, H_2SO_4	0·0009735
Aconitine, $C_{34}H_{47}NO_{11}$	0·012811
Atropine, $C_{17}H_{23}NO_3$	0·005741
Cinchonidine, $C_{21}H_{27}N_2O$	0·005841
Cinchonine, $C_{19}H_{25}N_2O$	0·005841
Combined Alkaloids of Cinchona	0·006139
Combined Alkaloids of Ipecacuanha	0·004768
Cocaine, $C_{17}H_{21}NO_4$	0·006018
Coniine, $C_8H_{17}N$	0·002524
Hydrastine, $C_{21}H_{27}NO_6$	0·007606
Morphine, crystallised, $C_{17}H_{19}NO_3 + H_2O$	0·006018
Morphine, anhydrous, $C_{17}H_{19}NO_3$	0·005661
Physostigmine $C_{15}H_{21}N_2O_2$	0·005464
Pilocarpine, $C_{11}H_{15}N_2O_2$	0·004133
Quinine, $C_{20}H_{24}N_2O_5$	0·006436
Strychnine, $C_{21}H_{22}N_2O_2$	0·006635

Seminormal Alcoholic Potassium Hydroxide Volumetric Solution

(27·87 grammes KOH in 1,000 c.c.)

1 c.c. $\frac{N}{2}$ KOH (alcoholic) is the equivalent of

	Gramme
Potassium Hydroxide, KOH	0·02787
Borneol, $C_{10}H_{15}O$	0·07649
Bornyl Acetate, $C_{10}H_{17}C_2H_3O_2$	0·09734
Menthol, $C_{10}H_{18}O$	0·07749
Menthyl Acetate, $C_{10}H_{19}C_2H_3O_2$	0·08834
Santalol, $C_{15}H_{22}O$	0·11026

Fiftieth-Normal Potassium Hydroxide Volumetric Solution

(1.1148 gramme KOH in 1,000 c.c.)

1 c.c. $\frac{N}{50}$ KOH is the equivalent of

	Gramme
Potassium Hydroxide, KOH	0.0011148
Sulphuric Acid, absolute, H_2SO_4	0.0009735
Aconitine, $C_{34}H_{47}NO_{11}$	0.012811
Atropine, $C_{17}H_{23}NO_3$	0.005741
Cinchonidine, $C_{19}H_{27}N_2O$	0.005841
Cinchonine, $C_{19}H_{27}N_2O$	0.005841
Combined Alkaloids of Cinchona Bark	0.006139
Combined Alkaloids of Ipecacuanha	0.004768
Cocaine, $C_{17}H_{21}NO_4$	0.006018
Coniine, $C_8H_{17}N$	0.002524
Hydrastine, $C_{21}H_{21}NO_4$	0.007606
Morphine, crystallised, $C_{17}H_{19}NO_3 + H_2O$	0.006018
Morphine, anhydrous $C_{17}H_{19}NO_3$	0.005661
Physostigmine, $C_{11}H_{15}N_3O_2$	0.005464
Pilocarpine, $C_{11}H_{17}N_2O_2$	0.004133
Quinine, $C_{20}H_{24}N_2O_5$	0.006436
Strychnine, $C_{21}H_{22}N_2O_2$	0.006635

Decinormal Potassium Dichromate Volumetric Solution(4.8713 grammes $K_2Cr_2O_7$ in 1,000 c.c.)1 c.c. $\frac{N}{10}$ $K_2Cr_2O_7$ is the equivalent of

	Gramme
Potassium Dichromate, $K_2Cr_2O_7$	0.0048713
Iron, Fe, in ferrous compounds	0.00555
Ferrous Carbonate, $FeCO_3$	0.011505
Ferrous Sulphate, anhydrous, $FeSO_4$	0.015085
Ferrous Sulphate, crystallised, $FeSO_4 + 7H_2O$	0.027601
Ferrous Sulphate, dried, $2FeSO_4 + 3H_2O$	0.017767
Sodium Thiosulphate, $Na_2S_2O_3 + 5H_2O$	0.024646

Decinormal Sodium Thiosulphate Volumetric Solution(24.646 grammes $Na_2S_2O_3 \cdot 5H_2O$ in 1,000 c.c.)1 c.c. $\frac{N}{10}$ $Na_2S_2O_3 \cdot 5H_2O$ is the equivalent of

	Gramme
Sodium Thiosulphate (Hyposulphite), $Na_2S_2O_3 + 5H_2O$	0.024646
Bromine, Br	0.007936
Chlorine, Cl	0.003518
Chromium Trioxide, CrO_3	0.003311
Iodine, I	0.01259
Iron, Fe (in ferric salts)	0.00555
Potassium Bromate, $KBrO_3$	0.002764

Decinormal Iodine Volumetric Solution

(12.59 grammes I in 1,000 c.c.)

1 c.c. $\frac{N}{10}$ I is the equivalent of

	Gramme
Iodine, I	0.01259
Arsenic, As	0.00372
Arsenic Trioxide (Arsenious Acid), As_2O_3	0.004911
Iron, Fe	0.002775
Potassium Sulphite, crystallised, $K_2SO_3 + 2H_2O$	0.009648
Sodium Bisulphite, $NaHSO_3$	0.005168
Sodium Thiosulphate (Hyposulphite) crystals, $Na_2S_2O_3 + 5H_2O$	0.024646
Sodium Sulphite, crystallised, $Na_2SO_3 + 7H_2O$	0.012520
Sulphur Dioxide, SO_2	0.003180
Antimony and Potassium Tartrate, crystallised, $2K(SbO)C_4H_4O_6 + H_2O$	0.016495

372 TESTS FOR PHARMACOPCEIAL SUBSTANCES

Decinormal Silver Nitrate Volumetric Solution(16·869 grammes $AgNO_3$ in 1,000 c.c.)1 c.c. $\frac{N}{10}$ $AgNO_3$ is equivalent to .

	Gramme
Silver Nitrate, $AgNO_3$	0·016869
Allyl Iso-thiocyanate, $CS.NC_2H_5$	0·00492
Ammonium Bromide, NH_4Br	0·009729
Ammonium Chloride, NH_4Cl	0·005311
Ammonium Iodide, NH_4I	0·014383
Bromine, Br	0·007936
Calcium Bromide, $CaBr_2$	0·009926
Chlorine, Cl	0·003518
Ferrous Bromide, anhydrous, $FeBr_2$	0·010711
Ferrous Iodide, FeI_2	0·015365
Hydriodic Acid, HI	0·012690
Hydrobromic Acid, HBr	0·008036
Hydrochloric Acid, HCl	0·003618
Hydrocyanic Acid, HCN (to first formation of precipitate)	0·005368
Hydrocyanic Acid, HCN (Potassium Chromate as indicator)	0·002684
Iodine, I	0·012590
Lithium Bromide, $LiBr$	0·008634
Potassium Bromide, KBr	0·011822
Potassium Chloride, KCl	0·007404
Potassium Cyanide, KCN (to first formation of precipitate)	0·012940
Potassium Iodide, KI	0·016476
Potassium Sulphocyanate, $KSCN$	0·009653
Sodium Bromide, $NaBr$	0·010224
Sodium Chloride, $NaCl$	0·005806
Sodium Iodide, NaI	0·014878
Strontium Bromide, $SrBr_2 + 6H_2O$	0·017647
Strontium Iodide, $SrI_2 + 6H_2O$	0·022301
Zinc Bromide, $ZnBr_2$	0·011181
Zinc Chloride, $ZnCl_2$	0·006763
Zinc Iodide, ZnI_2	0·015835

INDICATORS

Brasil-wood Solution.—Boil 50 grammes of finely cut Brazil-wood (the heartwood of *Peltophorum dubium*) with 100 c.c. of water during half an hour, replacing the water lost by evaporation from time to time. Allow the mixture to cool, strain, wash the contents of the strainer with water until 100 c.c. of strained liquid is obtained, add 25 c.c. of alcohol, and filter. Care should be taken to exclude ammoniacal vapours while filtering. This solution is turned purplish-red by alkalis, and yellow by acids.

Cochineal Test Solution.—Macerate 1 gramme of unbroken cochineal during four days with 20 c.c. of alcohol and 60 c.c. of water. Filter. The colour of this test solution is turned violet by alkalis, and yellowish-red by acids. Cochineal T.S. is useful in titrating alkaloids, inorganic acids, ammonia, the alkalis, and alkaline earths. The presence of salts of iron, alumina, or copper should be avoided. This indicator is useless when titrating organic acids.

Hematoxylin Test Solution.—Dissolve 0·2 gramme of hematoxylin in 100 c.c. of alcohol. Use about five drops for each titration. This indicator assumes a yellow to orange colour in acid solutions, and a violet to purple colour in alkaline solutions. The titration is complete when the change in colour remains permanent upon the addition of one drop of the volumetric solution after stirring the liquid.

Iodeosin Test Solution.—Dissolve 0.1 gramme of iodeosin, $C_{22}H_{14}I_4O_3$ (tetraiodofluorescein), in 100 c.c. of alcohol. This indicator becomes colourless in acid solutions, changing to pink in alkaline solutions. Dilute the solution to be titrated in a 200-c.c. flask with distilled water to about 100 c.c., add 20 c.c. of ether and five drops of the iodeosin T.S., cork, and shake well. Then add the volumetric alkali solution gradually, shaking well after each addition. The titration is complete when the lower aqueous solution retains a faint pink colour after shaking thoroughly. For assaying alkaloidal residues, dissolve the latter in a measured excess of volumetric acid solution, and transfer the acid solution to a 200-c.c. flask, washing the container well with water until the contents of the flask measure about 100 c.c. Then proceed as above.

Litmus Test Solution.—Exhaust powdered litmus with three separate and successive portions (representing about four times its weight) of boiling alcohol (which removes the undesirable colour erythrolitmin), each extraction lasting for about one hour. After draining off the alcohol, digest the residue with about an equal weight of cold water and filter. (This blue solution, which contains some alkali, after being acidulated, may be used to make red litmus paper.) Finally, extract the residue with about five times its weight of boiling water, and, after thoroughly cooling, filter. The addition of one drop of decinormal acid or alkali V.S. to 50 c.c. of water containing five drops of the indicator should produce a distinct change in colour. Preserve the filtrate, as test solution, in wide-mouthed bottles stoppered with loose plugs of cotton so as to exclude dust but admit air. The blue colour of litmus test solution is changed by acids to red, and this red colour by the addition of alkalies is restored to blue.

Methyl-orange Test Solution.—Dissolve 1 gramme of methyl orange, $NaC_{11}H_{14}N_2SO_3$ (the sodium or ammonium salt of dimethylamidoazobenzene sulphonic acid; also known as helianthin, tropeolin D, or Poirrier's Orange 3 P), in 1,000 c.c. of water. Add to it carefully, with constant stirring, decinormal sulphuric acid V.S., in drops, until the liquid turns red and just ceases to be transparent. Then filter.

Excessive quantities of this indicator should be avoided in titrating; from one to three drops is sufficient for a volume of from 50 to 100 c.c., or just enough is added to impart a faint tint to the solution, which if neutral should change to red or yellow respectively upon the addition of two drops of decinormal acid or alkali V.S.

Methyl-orange is suitable for titrating inorganic acids, alkalies, alkali carbonates or bicarbonates; also certain alkaloids, as morphine and quinine. It is not to be employed in titrating organic acids, nor in alcoholic or boiling solutions.

This indicator gives a yellow colour with alkalies and red with acids.

Phenolphthalein Test Solution.—Dissolve 1 gramme of phenolphthalein ($C_{20}H_{14}O_4$) in 50 c.c. of alcohol and dilute to 100 c.c. with water. About three drops is sufficient for 50 c.c. of the solution to be titrated; it gives a red colour with alkali hydroxides or carbonates, while acids render the solution colourless. Phenolphthalein may be employed in hot titrations. It is not suitable as an indicator for ammonia, but is largely used for organic acids, alkali hydroxides, and for carbonates and bicarbonates in boiling solutions.

Turmeric Tincture.—Digest any convenient quantity of ground turmeric root repeatedly with small quantities of water and discard the liquids. Then digest the dried residue for several days with six times its weight of alcohol, and filter.

TEST PAPERS

White unsized paper, free from wood pulp, is dipped in a sensitising solution. The sheets are placed to dry on lines of clean twine in an atmosphere free from dust and acid or ammoniacal vapours. The decoctions or tinctures must not come in contact with metals. The sensitised papers must be preserved in stoppered bottles.

For Brazil Paper.—Boil Brazil-wood chips in water for an hour, until a strongly coloured decoction results. Cool and filter. It is turned yellow by acids, purplish red by alkalies.

For Dahlia Paper.—Make a tincture in 30-per-cent. alcohol of the petals of violet or dark crimson dahlias. This is very sensitive. Turns green with alkalies, red with acids.

For Lead Paper.—The solution contains 5 per cent. lead acetate.

For Blue Litmus Paper.—Use litmus test solution.

For Red Litmus Paper.—Add to litmus test solution just sufficient of a highly diluted solution of hydrochloric acid to impart to it a faint red tint. Neither blue nor red litmus paper should have a very intense colour.

For Manganese Paper.—Solution of manganese sulphate. In an ozonised atmosphere it turns brown or black.

For Potassium Iodide and Starch Paper.—Prepare a mucilage with arrowroot, boiling thoroughly; when nearly cool add 5 per cent. potassium iodide. Dissolve.

For Turmeric Paper.—Use turmeric tincture. Turns brown with alkalies, and the original yellow colour is restored by acids, with the exception of boric acid, which, even in the presence of hydrochloric acid, turns the colour to reddish brown, and this is changed to bluish black by ammonia.

CHAPTER LII

ALCOHOL TABLE

*Percentage of Absolute Alcohol by Weight corresponding
to the Specific Gravity taken at 60° F. (15.5° C.)
(Specific Gravity of Water = 1)*

Specific Gravity	Per-centage	Specific Gravity	Per-centage	Specific Gravity	Per-centage
0.9981 .	1	0.9490 .	35	0.8772 .	68
0.9963 .	2	0.9472 .	36	0.8748 .	69
0.9944 .	3	0.9453 .	37	0.8724 .	70
0.9928 .	4	0.9433 .	38	0.8700 .	71
0.9912 .	5	0.9413 .	39	0.8676 .	72
0.9896 .	6	0.9394 .	40	0.8652 .	73
0.9880 .	7	0.9374 .	41	0.8629 .	74
0.9866 .	8	0.9353 .	42	0.8605 .	75
0.9852 .	9	0.9332 .	43	0.8581 .	76
0.9839 .	10	0.9311 .	44	0.8557 .	77
0.9826 .	11	0.9291 .	45	0.8533 .	78
0.9813 .	12	0.9269 .	46	0.8509 .	79
0.9800 .	13	0.9249 .	47	0.8484 .	80
0.9788 .	14	0.9227 .	48	0.8459 .	81
0.9775 .	15	0.9204 .	49	0.8435 .	82
0.9763 .	16	0.9183 .	50	0.8409 .	83
0.9751 .	17	0.9160 .	51	0.8385 .	84
0.9739 .	18	0.9138 .	52	0.8359 .	85
0.9727 .	19	0.9116 .	53	0.8333 .	86
0.9714 .	20	0.9090 .	54	0.8307 .	87
0.9702 .	21	0.9072 .	55	0.8282 .	88
0.9690 .	22	0.9049 .	56	0.8256 .	89
0.9677 .	23	0.9027 .	57	0.8229 .	90
0.9664 .	24	0.9004 .	58	0.8203 .	91
0.9651 .	25	0.8981 .	59	0.8176 .	92
0.9637 .	26	0.8958 .	60	0.8149 .	93
0.9622 .	27	0.8935 .	61	0.8122 .	94
0.9607 .	28	0.8911 .	62	0.8094 .	95
0.9592 .	29	0.8888 .	63	0.8065 .	96
0.9577 .	30	0.8865 .	64	0.8036 .	97
0.9560 .	31	0.8842 .	65	0.8006 .	98
0.9544 .	32	0.8818 .	66	0.7976 .	99
0.9526 .	33	0.8795 .	67	0.7446 .	100
0.9508 .	34				

ALCOHOL TABLE

*Percentage of Absolute Alcohol by Volume corresponding
to the Specific Gravity taken at 60° F. (15·5° C.)
(Specific Gravity of Water = 1)*

Specific Gravity	Per-centage	Specific Gravity	Per-centage	Specific Gravity	Per-centage
0·9985 .	1	0·9592 .	35	0·8949 .	68
0·9970 .	2	0·9579 .	36	0·8925 .	69
0·9956 .	3	0·9565 .	37	0·8900 .	70
0·9942 .	4	0·9550 .	38	0·8875 .	71
0·9928 .	5	0·9535 .	39	0·8850 .	72
0·9915 .	6	0·9519 .	40	0·8825 .	73
0·9902 .	7	0·9503 .	41	0·8799 .	74
0·9890 .	8	0·9487 .	42	0·8773 .	75
0·9878 .	9	0·9470 .	43	0·8747 .	76
0·9866 .	10	0·9452 .	44	0·8720 .	77
0·9854 .	11	0·9435 .	45	0·8693 .	78
0·9843 .	12	0·9417 .	46	0·8666 .	79
0·9832 .	13	0·9399 .	47	0·8639 .	80
0·9821 .	14	0·9381 .	48	0·8611 .	81
0·9811 .	15	0·9362 .	49	0·8583 .	82
0·9800 .	16	0·9343 .	50	0·8555 .	83
0·9790 .	17	0·9323 .	51	0·8526 .	84
0·9780 .	18	0·9303 .	52	0·8496 .	85
0·9770 .	19	0·9283 .	53	0·8466 .	86
0·9760 .	20	0·9263 .	54	0·8436 .	87
0·9750 .	21	0·9242 .	55	0·8405 .	88
0·9740 .	22	0·9221 .	56	0·8373 .	89
0·9729 .	23	0·9200 .	57	0·8339 .	90
0·9719 .	24	0·9178 .	58	0·8306 .	91
0·9709 .	25	0·9156 .	59	0·8272 .	92
0·9698 .	26	0·9134 .	60	0·8237 .	93
0·9688 .	27	0·9112 .	61	0·8201 .	94
0·9677 .	28	0·9090 .	62	0·8164 .	95
0·9666 .	29	0·9067 .	63	0·8125 .	96
0·9655 .	30	0·9044 .	64	0·8084 .	97
0·9643 .	31	0·9021 .	65	0·8047 .	98
0·9631 .	32	0·8997 .	66	0·7995 .	99
0·9618 .	33	0·8973 .	67	0·7946 .	100
0·9605 .	34				

CHAPTER LIII

TABLE OF THERMOMETRIC EQUIVALENTS ACCORDING
TO THE CENTIGRADE AND FAHRENHEIT SCALES

To convert Degrees F. into Degrees C.: $\frac{(F^{\circ} - 32)}{9} \times 5$.

To convert Degrees C. into Degrees F.: $\frac{C^{\circ} \times 9}{5} + 32$.

Centigrade	Fahrenheit	Centigrade	Fahrenheit	Centigrade	Fahrenheit
0°	= 32.0°	34°	= 93.2°	68°	= 154.4°
1°	= 33.8°	35°	= 95.0°	69°	= 156.2°
2°	= 35.6°	36°	= 96.8°	70°	= 158.0°
3°	= 37.4°	37°	= 98.6°	71°	= 159.8°
4°	= 39.2°	38°	= 100.4°	72°	= 161.6°
5°	= 41.0°	39°	= 102.2°	73°	= 163.4°
6°	= 42.8°	40°	= 104.0°	74°	= 165.2°
7°	= 44.6°	41°	= 105.8°	75°	= 167.0°
8°	= 46.4°	42°	= 107.6°	76°	= 168.8°
9°	= 48.2°	43°	= 109.4°	77°	= 170.6°
10°	= 50.0°	44°	= 111.2°	78°	= 172.4°
11°	= 51.8°	45°	= 113.0°	79°	= 174.2°
12°	= 53.6°	46°	= 114.8°	80°	= 176.0°
13°	= 55.4°	47°	= 116.6°	81°	= 177.8°
14°	= 57.2°	48°	= 118.4°	82°	= 179.6°
15°	= 59.0°	49°	= 120.2°	83°	= 181.4°
16°	= 60.8°	50°	= 122.0°	84°	= 183.2°
17°	= 62.6°	51°	= 123.8°	85°	= 185.0°
18°	= 64.4°	52°	= 125.6°	86°	= 186.8°
19°	= 66.2°	53°	= 127.4°	87°	= 188.6°
20°	= 68.0°	54°	= 129.2°	88°	= 190.4°
21°	= 69.8°	55°	= 131.0°	89°	= 192.2°
22°	= 71.6°	56°	= 132.8°	90°	= 194.0°
23°	= 73.4°	57°	= 134.6°	91°	= 195.8°
24°	= 75.2°	58°	= 136.4°	92°	= 197.6°
25°	= 77.0°	59°	= 138.2°	93°	= 199.4°
26°	= 78.8°	60°	= 140.0°	94°	= 201.2°
27°	= 80.6°	61°	= 141.8°	95°	= 203.0°
28°	= 82.4°	62°	= 143.6°	96°	= 204.8°
29°	= 84.2°	63°	= 145.4°	97°	= 206.6°
30°	= 86.0°	64°	= 147.2°	98°	= 208.4°
31°	= 87.8°	65°	= 149.0°	99°	= 210.2°
32°	= 89.6°	66°	= 150.8°	100°	= 212.0°
33°	= 91.4°	67°	= 152.6°		

CHAPTER LIV

MELTING POINTS OF THE MORE COMMON ELEMENTS

Antimony	425° C.	Silver	1000° C.
Bismuth	270° "	Steel	1300-1400° "
Cadmium	315° "	Tin	235° "
Cast Iron	1050-1200° "	Wrought Iron	1500-1600° "
Copper	1090° "	Zinc	423° "
Lead	334° "		

ATOMIC WEIGHTS OF ELEMENTS

Aluminium	Al	26.9	Neodymium	Nd	142.5
Antimony	Sb	119.3	Neon	Ne	19.9
Argon	Ar	39.6	Nickel	Ni	58.3
Arsenic	As	74.4	Niobium	Nb	93.3
Barium	Ba	136.4	Nitrogen	N	13.93
Beryllium	Be	9.03	Osmium	Os	189.6
Bismuth	Bi	206.9	Oxygen	O	15.88
Boron	B	10.9	Palladium	Pd	105.7
Bromine	Br	79.36	Phosphorus	P	30.77
Cadmium	Cd	111.6	Platinum	Pt	193.3
Cæsium	Cs	131.9	Potassium	K	38.86
Calcium	Ca	39.8	Radium	Ra	223
Carbon	C	11.91	Rhodium	Rh	102.2
Cerium	Ce	139.2	Rubidium	Rb	84.8
Chlorine	Cl	35.18	Ruthenium	Ru	100.9
Chromium	Cr	51.7	Samarium	Sm	148.9
Cobalt	Co	58.56	Scandium	Sc	43.8
Copper	Cu	63.1	Selenium	Se	78.6
Didymium	Di	139.4	Silicon	Si	28.2
Erbium	Er	164.8	Silver	Ag	107.12
Fluorine	F	18.9	Sodium	Na	22.88
Gadolinium	Gd	155	Strontium	Sr	86.94
Gallium	Ga	69.5	Sulphur	S	31.83
Germanium	Ge	71.9	Tantalum	Ta	181.6
Gold	Au	195.7	Tellurium	Te	126.6
Helium	He	4	Terbium	Tb	158.8
Hydrogen	H	1.000	Thallium	Tl	202.6
Indium	In	113.1	Thorium	Th	230.8
Iodine	I	125.90	Thulium	Tu	169.7
Iridium	Ir	191.5	Tin	Sn	118.1
Iron	Fe	55.5	Titanium	Ti	47.7
Krypton	Kr	81.2	Tungsten	W	182.6
Lanthanum	La	137.9	Uranium	U	236.7
Lead	Pb	205.35	Vanadium	V	50.8
Lithium	Li	6.98	Xenon	Xe	127
Magnesium	Mg	24.18	Ytterbium	Yb	171.7
Manganese	Mn	54.6	Yttrium	Yt	88.3
Mercury	Hg	198.5	Zinc	Zn	64.9
Molybdenum	Mo	95.3	Zirconium	Zr	89.9

TABLE OF SPECIFIC GRAVITIES OF THE MORE COMMON
ELEMENTS COMPARED WITH WATER

Aluminum	2.6	Magnesium	1.74
Antimony	6.7	Manganese	8.0
Arsenic	5.9	Mercury	13.596
Bismuth	9.8	Nickel	8.9
Cadmium	8.6	Palladium	11.4
Calcium	1.58	Platinum	21.5
Chromium	7.3	Potassium	0.865
Cobalt	8.5	Rubidium	1.52
Copper	8.9	Silver	10.5
<i>Diamond</i>	3.531-3.501	Sodium	0.974
Gold	19.3	Strontium	2.54
Iridium	22.4	Thallium	11.8
Iron	7.8	Tin	7.3
Lead	11.4	Zinc	7.1
Lithium	0.594		

CHAPTER LV

MOLECULAR WEIGHTS AND FORMULÆ OF THE
PRINCIPAL CHEMICAL SUBSTANCES (H = 1)

Acetaldehyde (<i>see</i> Aldehyde, Acetic)		
Acetanilide (Phenylacetamide)	C_8H_9NO	134.09
Acetone	$(CH_3)_2CO$	57.61
Acetphenetidine	$C_{10}H_{13}NO_2$	577.79
Acid—		
Acetic	$HC_2H_3O_2$	59.58
Arsenious (<i>see</i> Arsenic Trioxide)		
Aurochloric (<i>see</i> Acid, Chlorauric)		
Benzoic	$HC_6H_5O_2$	121.13
Boric	H_3BO_3	61.54
Camphoric	$H_2C_{10}H_{11}O_4$	198.62
Carbolic (<i>see</i> Phenol)		
Carbonic (in solution)	H_2CO_3	61.55
Chlorauric (Aurochloric)	$HAuCl_4 + 4H_2O$	408.94
Chlorauric, Anhydrous (Gold Chloride)	$AuCl_3$	301.24
Chloroplatinic	$H_2PtCl_6 + 6H_2O$	513.66
Chromic (<i>see</i> Chromium Trioxide)		
Cinnamic	$HC_9H_7O_2$	146.95
Citric	$H_2C_6H_5O_7 + H_2O$	208.50
Citric, Anhydrous	$H_2C_6H_5O_7$	190.62
Formic	$HCHO_2$	45.67
Gallic	$HC_7H_5O_8 + H_2O$	186.65
Gallic, Anhydrous	$HC_7H_5O_8$	168.77
Hydriodic	HI	126.9
Hydrobromic	HBr	80.36
Hydrochloric	HCl	36.18
Hydrocyanic	HCN	26.84
Hydrofluoric	HF	19.9
Hypophosphorous	H_3PO_2	65.53
Lactic	$HC_3H_5O_3$	89.37
Molybdic	H_2MoO_4	160.82
Nitric	HNO_3	62.57
Nitrous	HNO_2	46.69
Oleic	$HC_{18}H_{33}O_2$	280.14
Oxalic	$H_2C_2O_4 + 2H_2O$	125.10
Oxalic, Anhydrous	$H_2C_2O_4$	89.34
Phosphoric	H_3PO_4	97.29
Phosphorous	H_3PO_3	81.41
Picric	$HC_6H_3(NO_2)_3O$	227.41
Pyroboric (Tetraboric)	$H_2B_4O_7$	158.76
Pyrogallol (<i>see</i> Pyrogallol)		
Salicylic	$HC_7H_5O_3$	137.01
Stearic	$HC_{18}H_{35}O_2$	282.14
Succinic	$H_2C_4H_4O_4$	117.16
Sulphanilic	$HC_6H_4(NH_2)SO_3 + 3H_2O$	225.5

Acid—			
Sulphanilic, Anhydrous .	$\text{HC}_6\text{H}_4(\text{NH}_2)\text{SO}_3$		171·86
Sulphuric	H_2SO_4		97·35
Sulphurous	H_2SO_3		81·47
Tannic	$\text{HC}_{11}\text{H}_8\text{O}_5$		319·66
Tartaric	$\text{H}_2\text{C}_4\text{H}_4\text{O}_6$		148·92
Tetraboric (<i>see</i> Acid, Pyro- boric)			
Trichloroacetic	$\text{HC}_2\text{Cl}_3\text{O}_2$		162·12
Valerianic	$\text{HC}_5\text{H}_9\text{O}_2$		101·31
Aconitine	$\text{C}_{34}\text{H}_{47}\text{NO}_{11}$		640·55
Agaricin	$\text{C}_{16}\text{H}_{20}\text{O}_5 + \text{H}_2\text{O}$		317·84
Alcohol—			
Amylic	$\text{C}_6\text{H}_{11}\text{OH}$		87·43
Ethylic	$\text{C}_2\text{H}_5\text{OH}$		45·70
Methylic	CH_3OH		31·79
Aldehyde—			
Acetic	$\text{C}_2\text{H}_4\text{O}$		47·03
Benzoic (<i>see</i> Benzalde- hyde)			
Cinnamic (<i>see</i> Cinnamic Aldehyde)			
Formic (<i>see</i> Formalde- hyde)			
Allyl-iso-thiocyanate .	CSNC_3H_5		98·40
Allyl-sulphocarbamide (<i>see</i> Thiosinamine)			
Alum, Anhydrous	$\text{AlK}(\text{SO}_4)_2$		256·46
(Ammonia)	$\text{AlNH}_4(\text{SO}_4)_2 + 12\text{H}_2\text{O}$		450·08
(Potassium)	$\text{AlK}(\text{SO}_4)_2 + 12\text{H}_2\text{O}$		471·02
Aluminium—			
Hydroxide	$\text{Al}(\text{OH})_3$		77·54
Oxide	Al_2O_3		101·44
Silicate	$\text{H}_2\text{Al}_2\text{Si}_2\text{O}_8 + \text{H}_2\text{O}$		257·12
Sulphate	$\text{Al}_2(\text{SO}_4)_3 + 16\text{H}_2\text{O}$		625·93
Sulphate, Anhydrous	$\text{Al}_2(\text{SO}_4)_3$		339·85
Ammonia	NH_3		16·93
Ammonium—			
Acetate	$\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$		76·51
Arsenite (Metarsenite)	NH_4AsO_2		124·09
Benzoate	$\text{NH}_4\text{C}_6\text{H}_5\text{O}_2$		138·06
Bromide	NH_4Br		97·29
Carbonate (normal)	$(\text{NH}_4)_2\text{CO}_3$		95·41
Carbonate, B.P.	$\text{NH}_4\text{HCO}_3\text{NH}_4\text{NH}_4\text{CO}_3$		156·01
Chloride	NH_4Cl		53·11
Chloroplatinate	$(\text{NH}_4)_2\text{PtCl}_6$		440·24
Citrate	$(\text{NH}_4)_3\text{C}_6\text{H}_5\text{O}_7$		241·41
Hydrogen Sulphide	NH_4HS		50·76
Iodide	NH_4I		143·83
Lactate	$\text{NH}_4\text{C}_3\text{H}_5\text{O}_2$		106·30
Molybdate	$(\text{NH}_4)_6\text{Mo}_7\text{O}_{24} + 4\text{H}_2\text{O}$		1227·32
Nitrate	NH_4NO_3		79·50
Oxalate	$(\text{NH}_4)_2\text{C}_2\text{O}_4 + \text{H}_2\text{O}$		141·08
Oxalate, Anhydrous	$(\text{NH}_4)_2\text{C}_2\text{O}_4$		123·20
Phosphate	$(\text{NH}_4)_2\text{HPO}_4$		131·15
Salicylate	$\text{NH}_4\text{C}_7\text{H}_5\text{O}_3$		153·94
Sodium Phosphate	$\text{NH}_4\text{NaHPO}_4 + 4\text{H}_2\text{O}$		207·62
Sulphate	$(\text{NH}_4)_2\text{SO}_4$		131·21
Sulphide	$(\text{NH}_4)_2\text{S}$		67·69
Sulphydroxide (<i>see</i> Am- monium Hydrogen Sul- phide)			
Tartrate	$(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$		182·78
Valerianate	$\text{NH}_4\text{C}_5\text{H}_9\text{O}_2$		118·24
Amyl Nitrite	$\text{C}_5\text{H}_{11}\text{NO}_2$		116·24
Amylene Hydrate	$\text{C}_6\text{H}_{12}\text{O}$		87·43
Anethol	$\text{C}_{10}\text{H}_{12}\text{O}$		146·98
Aniline	$\text{C}_6\text{H}_5\text{NH}_2$		92·39

Antimony—

Oxide (<i>see</i> Antimony Tri-oxide)		
Pentasulphide	Sb_2S_5	397.75
Potassium Tartrate	$2\text{K}(\text{SbO})\text{C}_4\text{H}_4\text{O}_6 + \text{H}_2\text{O}$	659.80
Potassium Tartrate, Anhydrous	$\text{K}(\text{SbO})\text{C}_4\text{H}_4\text{O}_6$	320.96
Trioxide (Oxide)	Sb_2O_3	286.24
Trisulphide	Sb_2S_3	334.09
Antipyrine	$\text{C}_{11}\text{H}_{12}\text{N}_2\text{O}$	186.75
Apomorphine Hydrochloride	$\text{C}_{17}\text{H}_{17}\text{NO}_2\text{HCl}$	301.34
Arsenic Trioxide (Arsenious Acid)	As_2O_3	196.44
Arsenious Iodide	AsI_3	452.10
(Penta-) Sulphide	As_2S_5	307.95
Atropine	$\text{C}_{17}\text{H}_{23}\text{NO}_3$	287.04
Sulphate	$(\text{C}_{17}\text{H}_{23}\text{NO}_3)_2\text{H}_2\text{SO}_4$	671.43
Barium Carbonate	BaCO_3	195.95
Chloride	$\text{BaCl}_2 + 2\text{H}_2\text{O}$	242.52
Chloride, Anhydrous	BaCl_2	206.76
Chromate	BaCrO_4	251.62
Dioxide	BaO_2	168.16
Hydroxide	$\text{Ba}(\text{OH})_2 + 8\text{H}_2\text{O}$	313.20
Hydroxide, Anhydrous	$\text{Ba}(\text{OH})_2$	170.16
Nitrate	$\text{Ba}(\text{NO}_3)_2$	259.54
Sulphate	BaSO_4	231.75
Sulphide	BaS	168.23
Benzaldehyde (Benzoic Aldehyde)	$\text{C}_7\text{H}_6\text{O}$	105.25
Benzene (Benzol)	C_6H_6	77.46
Benzoyl-sulphonic-imide	$\text{C}_7\text{H}_5\text{NSO}_2$	181.77
Beta Naphthol	$\text{C}_{10}\text{H}_7\text{OH}$	142.98
Bismuth—		
Citrate	$\text{BiC}_6\text{H}_5\text{O}_7$	394.52
Nitrate (normal)	$\text{Bi}(\text{NO}_3)_3 + 5\text{H}_2\text{O}$	481.01
Subcarbonate (approximately)	$(\text{BiO})_2\text{CO}_3$	505.11
Subgallate (approximately)	$\text{Bi}(\text{OH})_2\text{C}_7\text{H}_5\text{O}_3$	408.43
Subnitrate (approximately)	$\text{Bi}(\text{OH})_2\text{NO}_3$	302.23
Subsalicylate (approximately)	$\text{Bi}(\text{OH})_2\text{C}_7\text{H}_5\text{O}_3$	376.67
Sulphide	Bi_2S_3	509.29
Trioxide	Bi_2O_3	461.44
Borneol	$\text{C}_{10}\text{H}_{18}\text{O}$	152.98
Bornyl Acetate	$\text{C}_{10}\text{H}_{17}\text{C}_2\text{H}_5\text{O}_2$	194.68
Boron Trioxide	B_2O_3	69.44
Bromoform	CHBr_3	250.99
Brucine	$\text{C}_{22}\text{H}_{28}\text{N}_2\text{O}_4 + 4\text{H}_2\text{O}$	462.83
Anhydrous	$\text{C}_{22}\text{H}_{28}\text{N}_2\text{O}_4$	391.31
Cadmium—		
Sulphate	$3\text{CdSO}_4 + 8\text{H}_2\text{O}$	763.89
Sulphide	CdS	143.43
Caffeine	$\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2 + \text{H}_2\text{O}$	210.64
Anhydrous	$\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2$	192.76
Calcium—		
Bromide	CaBr_2	198.52
Carbonate	CaCO_3	99.35
Chloride	$\text{CaCl}_2 + 6\text{H}_2\text{O}$	217.44
Chloride, Anhydrous	CaCl_2	110.16
Fluoride	CaF_2	77.60
Hydroxide	$\text{Ca}(\text{OH})_2$	73.56
Hypophosphite	$\text{Ca}(\text{PH}_2\text{O}_2)_2$	168.86
Oxalate	$\text{CaC}_2\text{O}_4 + \text{H}_2\text{O}$	145.02
Oxide	CaO	55.68
Phosphate	$\text{Ca}_3(\text{PO}_4)_2$	307.98

Calcium—		
Sulphate (Gypsum)	$\text{CaSO}_4 + 2\text{H}_2\text{O}$	170.91
Sulphate, Anhydrous	CaSO_4	135.15
Sulphide (Monosulphide)	CaS	71.63
Camphor	$\text{C}_{10}\text{H}_{16}\text{O}$	150.98
Camphor, Monobromated	$\text{C}_{10}\text{H}_{15}\text{BrO}$	229.34
Carbon Disulphide	CS_2	75.57
Carvone	$\text{C}_{10}\text{H}_{14}\text{O}$	148.98
Cephaeline	$\text{C}_{14}\text{H}_{19}\text{NO}_2$	231.43
Cerium Oxalate	$\text{Ce}_2(\text{C}_2\text{O}_4)_3 + 10\text{H}_2\text{O}$	719.22
Oxalate Anhydrous	$\text{Ce}_2(\text{C}_2\text{O}_4)_3$	540.42
Chloral, Anhydrous	$\text{C}_2\text{HCl}_2\text{O}$	146.24
Hydrate	$\text{C}_2\text{HCl}_2\text{O} + \text{H}_2\text{O}$	164.12
Chloroformamide	$\text{C}_2\text{H}_4\text{Cl}_2\text{NO}_2$	190.96
Chloroform	CHCl_3	118.45
Chromium Oxide	Cr_2O_3	151.04
Trioxide (Chromic Acid)	CrO_3	99.34
Chrysarobin	$\text{C}_{20}\text{H}_{20}\text{O}_7$	494.46
Cinchonidine	$\text{C}_{19}\text{H}_{22}\text{N}_2\text{O}$	293.03
Salicylate	$\text{C}_{19}\text{H}_{22}\text{N}_2\text{OC}_7\text{H}_5\text{O}_2$	429.04
Sulphate	$(\text{C}_{19}\text{H}_{22}\text{N}_2\text{O})_2\text{H}_2\text{SO}_4 + 3\text{H}_2\text{O}$	735.05
Sulphate, Anhydrous	$(\text{C}_{19}\text{H}_{22}\text{N}_2\text{O})_2\text{H}_2\text{SO}_4$	681.41
Cinchonine	$\text{C}_{19}\text{H}_{22}\text{N}_2\text{O}$	292.03
Sulphate	$(\text{C}_{19}\text{H}_{22}\text{N}_2\text{O})_2\text{H}_2\text{SO}_4 + 2\text{H}_2\text{O}$	717.17
Sulphate, Anhydrous	$(\text{C}_{19}\text{H}_{22}\text{N}_2\text{O})_2\text{H}_2\text{SO}_4$	681.41
Cineol (Eucalyptol)	$\text{C}_{10}\text{H}_{18}\text{O}$	152.98
Cinnamic Aldehyde	$\text{C}_9\text{H}_8\text{O}$	131.07
Citral	$\text{C}_{10}\text{H}_{16}\text{O}$	150.98
Cobaltous Nitrate	$\text{Co}(\text{NO}_3)_2 + 6\text{H}_2\text{O}$	288.98
Sulphate	$\text{CoSO}_4 + 7\text{H}_2\text{O}$	279.07
Cocaine	$\text{C}_{17}\text{H}_{21}\text{NO}$	300.92
Hydrochloride	$\text{C}_{17}\text{H}_{21}\text{NO} \cdot \text{HCl}$	337.10
Codeine	$\text{C}_{18}\text{H}_{21}\text{NO}_2 + \text{H}_2\text{O}$	314.83
Anhydrous	$\text{C}_{18}\text{H}_{21}\text{NO}_2$	296.95
Phosphate	$\text{C}_{18}\text{H}_{21}\text{NO}_2\text{H}_3\text{PO}_4 + 2\text{H}_2\text{O}$	430.0
Phosphate, Anhydrous	$\text{C}_{18}\text{H}_{21}\text{NO}_2\text{H}_3\text{PO}_4$	394.24
Sulphate	$(\text{C}_{18}\text{H}_{21}\text{NO}_2)_2\text{H}_2\text{SO}_4 + 5\text{H}_2\text{O}$	780.65
Sulphate, Anhydrous	$(\text{C}_{18}\text{H}_{21}\text{NO}_2)_2\text{H}_2\text{SO}_4$	691.25
Colchicine	$\text{C}_{20}\text{H}_{25}\text{NO}_6$	396.23
Coniine	$\text{C}_8\text{H}_{17}\text{N}$	126.21
Oresol	$\text{C}_6\text{H}_4(\text{CH}_3)\text{OH}$	107.25
Cupric Ammonium Sulphate	$\text{Cu}(\text{NH}_4)_2\text{SO}_4 + \text{H}_2\text{O}$	244.05
Sulphate	$\text{CuSO}_4 + 5\text{H}_2\text{O}$	247.85
Sulphate, Anhydrous	CuSO_4	158.45
Sulphide	CuS	94.93
Tartrate	$\text{CuC}_4\text{H}_4\text{O}_6 + 3\text{H}_2\text{O}$	263.66
Diethylsulphone - dimethylmethane (<i>see</i> Sulphonal)		
Diethylsulphone - methyl-ethyl-methane (<i>see</i> Trional)		
Diphenylamine	$(\text{C}_6\text{H}_5)_2\text{NH}$	167.85
Elaterin	$\text{C}_{20}\text{H}_{28}\text{O}_2$	345.60
Emetine	$\text{C}_{17}\text{H}_{23}\text{NO}_2$	245.34
Ether (Ethyl Oxide)	$(\text{C}_2\text{H}_5)_2\text{O}$	73.52
Ethyl—		
Acetate	$\text{C}_4\text{H}_9\text{C}_2\text{H}_3\text{O}_2$	87.40
Carbamate	$\text{C}_4\text{H}_9\text{NO}_2$	88.42
Chloride	$\text{C}_2\text{H}_5\text{Cl}$	64.00
Hydroxide (<i>see</i> Alcohol, Ethylic)		
Nitrite	$\text{O}_2\text{H}_3\text{NO}_2$	74.51
Oxide (<i>see</i> Ether)		
Eucalyptol (<i>see</i> Cineol)		
Eugenol	$\text{C}_{10}\text{H}_{12}\text{O}_2$	162.86
Ferric Acetate	$\text{Fe}(\text{C}_2\text{H}_3\text{O}_2)_3$	231.24
Ammonium Sulphate	$\text{FeNH}_4(\text{SO}_4)_2 + 12\text{H}_2\text{O}$	478.69

Ferric Ammonium Sulphate, Anhydrous	$\text{FeNH}_4(\text{SO}_4)_2$	264.13
Chloride	$\text{FeCl}_3 + 6\text{H}_2\text{O}$	268.32
Chloride, Anhydrous	FeCl_3	161.04
Hydroxide	$\text{Fe}(\text{OH})_3$	106.14
Hypophosphite	$\text{Fe}(\text{PH}_2\text{O}_2)_3$	249.09
Nitrate	$\text{Fe}(\text{NO}_3)_3$	240.21
Oxide	Fe_2O_3	158.64
Phosphate (normal)	FePO_4	149.79
Pyrophosphate (normal)	$\text{Fe}_2(\text{P}_2\text{O}_7)_3$	740.10
Sulphate	$\text{Fe}_2(\text{SO}_4)_3$	397.05
Ferrous Bromide	$\text{FeBr}_2 + 6\text{H}_2\text{O}$	321.50
Bromide, Anhydrous	FeBr_2	214.22
Carbonate	FeCO_3	115.05
Iodide	FeI_2	307.30
Lactate	$\text{Fe}(\text{C}_2\text{H}_3\text{O}_2)_2 + 3\text{H}_2\text{O}$	285.88
Sulphate	$\text{FeSO}_4 + 7\text{H}_2\text{O}$	276.01
Sulphate, Anhydrous	FeSO_4	150.85
Sulphide	FeS	87.33
Formaldehyde (Formic Aldehyde)	CH_2O	29.79
Glucose (<i>see</i> Sugar, Grape)		
Gluside (<i>see</i> Benzoyl-sulphonic-imide)		
Glycerin (Glycerol)	$\text{C}_3\text{H}_8(\text{OH})_3$	91.37
Glyceryl Trinitrate (Nitroglycerin)	$\text{C}_3\text{H}_5(\text{NO}_3)_3$	225.44
Gold Chloride, Anhydrous (<i>see</i> Acid, Chlorauric, Anhydrous)		
Trichloride	AuCl_3	301.21
Guaiacol	$\text{C}_8\text{H}_8\text{O}_2$	123.13
Carbonate	$(\text{C}_8\text{H}_7\text{O})_2\text{CO}_3$	272.05
Heroin Hydrochloride	$\text{C}_{17}\text{H}_{17}(\text{C}_2\text{H}_3\text{O}_2)_2\text{NOHCl}$	402.62
Hexamethylenetetramine	$\text{C}_6\text{H}_{12}\text{N}_4$	139.18
Homatropine Hydrobromide	$\text{C}_{16}\text{H}_{21}\text{NO}_3\text{HBr}$	353.49
Hydrastine	$\text{C}_{21}\text{H}_{21}\text{NO}_6$	380.32
Hydrochloride	$\text{C}_{21}\text{H}_{21}\text{NO}_6\text{HCl}$	416.50
Hydrastinine Hydrochloride	$\text{C}_{17}\text{H}_{17}\text{NO}_2\text{HCl}$	223.88
Hydrogen Dioxide	H_2O_2	33.76
Sulphide (Hydrosulphuric Acid)	H_2S	33.83
Hyoscine Hydrobromide	$\text{C}_{17}\text{H}_{21}\text{NO}_4\text{HBr} + 3\text{H}_2\text{O}$	434.92
Hydrobromide, Anhydrous	$\text{C}_{17}\text{H}_{21}\text{NO}_4\text{HBr}$	381.28
Hyoscyamine Hydrobromide	$\text{C}_{17}\text{H}_{21}\text{NO}_3\text{HBr}$	367.40
Sulphate	$(\text{C}_{17}\text{H}_{21}\text{NO}_3)_2\text{H}_2\text{SO}_4$	671.43
Iodeosin (Tetraiodo-fluorescein)	$\text{C}_{20}\text{H}_3\text{I}_4\text{O}_3$	829.20
Iodoform	CHI_3	390.61
Iodol (Tetraiodopyrrol)	$\text{C}_4\text{I}_4\text{NH}$	566.17
Iron Salts (<i>see under</i> Ferric and Ferrous)		
Lead—		
Acetate	$\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2 + 3\text{H}_2\text{O}$	376.15
Acetate, Anhydrous	$\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2$	322.51
Carbonate	$(\text{PbCO}_3)_2\text{Pb}(\text{OH})_2$	768.91
Chloride	PbCl_2	275.71
Chromate	PbCrO_4	320.57
Iodide	PbI_2	457.15
Nitrate	$\text{Pb}(\text{NO}_3)_2$	328.49
Oxide	PbO	221.23
Subacetate (approximately)	$\text{Pb}_2\text{O}(\text{C}_2\text{H}_3\text{O}_2)_2$	543.74
Sulphate	PbSO_4	300.70
Sulphide	PbS	237.18
Limonene	$\text{C}_{10}\text{H}_{16}$	135.10
Linalyl Acetate	$\text{C}_{10}\text{H}_{11}\text{C}_2\text{H}_3\text{O}_2$	194.68

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Lithium—		
Benzoate	$\text{LiC}_6\text{H}_5\text{O}_2$	127·11
Bromide	LiBr	86·34
Carbonate	Li_2CO_3	73·51
Citrate	$\text{Li}_3\text{C}_6\text{H}_5\text{O}_7 + 4\text{H}_2\text{O}$	280·08
Phosphate (dried at 100°C.)	Li_3PO_4	115·23
Salicylate	$\text{LiC}_7\text{H}_5\text{O}_3$	142·99
Magnesium—		
Carbonate (approximately)	$(\text{MgCO}_3)_x\text{Mg}(\text{OH})_2 + 5\text{H}_2\text{O}$	482·26
Oxide	MgO	40·06
Pyroarsenate	$\text{Mg}_2\text{As}_2\text{O}_7$	308·32
Pyrophosphate	$\text{Mg}_2\text{P}_2\text{O}_7$	221·06
Sulphate	$\text{MgSO}_4 + 7\text{H}_2\text{O}$	244·69
Sulphate, Anhydrous	MgSO_4	119·53
Manganese—		
Dioxide	MnO_2	86·36
Hypophosphite	$\text{Mn}(\text{PH}_2\text{O}_2)_2 + \text{H}_2\text{O}$	201·54
Manganous Oxide	MnO	70·48
Sulphate	$\text{MnSO}_4 + 4\text{H}_2\text{O}$	221·47
Sulphate, Anhydrous	MnSO_4	149·95
Menthol	$\text{C}_{10}\text{H}_{19}\text{OH}$	154·98
Menthyl Acetate	$\text{C}_{10}\text{H}_{19}\text{C}_2\text{H}_3\text{O}_2$	196·68
Mercuric Amido-chloride		
Chloride	HgNH_2Cl	249·61
Cyanide	HgCl_2	268·86
Iodide	$\text{Hg}(\text{CN})_2$	250·18
Nitrate	HgI_2	450·30
Nitrate, Anhydrous	$\text{Hg}(\text{NO}_3)_2 + 4\text{H}_2\text{O}$	393·16
Oxide	$\text{Hg}(\text{NO}_3)_2$	321·64
Potassium Iodide	HgO	214·38
Subsulphate	$\text{HgI}_2 + 2\text{KI}$	779·82
Sulphate	$\text{Hg}(\text{HgO})_2\text{SO}_4$	722·61
Sulphide	HgSO_4	293·85
Mercurous Chloride		
Iodide	HgS	230·33
Nitrate	HgCl	233·68
Sulphate	HgI	324·40
Methylacetanilide	$\text{HgNO}_3 + \text{H}_2\text{O}$	277·95
Methylene Blue	Hg_2SO_4	492·35
Methyl Orange	$\text{C}_6\text{H}_5\text{N}(\text{CH}_3)\text{C}_2\text{H}_3\text{O}$	148·00
Methyl Salicylate	$\text{C}_{10}\text{H}_{13}\text{N}_3\text{SCl}$	317·36
Morphine	$\text{NaC}_{10}\text{H}_{11}\text{N}_3\text{SO}_3$	324·88
Anhydrous	$\text{CH}_3\text{C}_2\text{H}_3\text{O}_3$	150·92
Acetate (variable)	$\text{C}_{17}\text{H}_{19}\text{NO}_3 + \text{H}_2\text{O}$	300·92
Hydrochloride	$\text{C}_{17}\text{H}_{19}\text{NO}_3$	283·04
Hydrochloride, Anhy- drous	$\text{C}_{17}\text{H}_{19}\text{NO}_3\text{C}_2\text{H}_3\text{O}_2 + 3\text{H}_2\text{O}$	396·26
Sulphate	$\text{C}_{17}\text{H}_{19}\text{NO}_3\text{HCl} + 3\text{H}_2\text{O}$	372·86
Sulphate, Anhydrous	$\text{C}_{17}\text{H}_{19}\text{NO}_3\text{HCl}$	319·22
Naphthalene	$(\text{C}_{17}\text{H}_{19}\text{NO}_3)_2\text{H}_2\text{SO}_4 + 5\text{H}_2\text{O}$	752·83
Naphthol (<i>see</i> Beta Naphthol)	$(\text{C}_{17}\text{H}_{19}\text{NO}_3)_2\text{H}_2\text{SO}_4$	663·43
Naphthylamine Acetate	C_{10}H_8	127·10
Nickelous Oxide	$\text{C}_{10}\text{H}_7\text{NH}_2\text{HC}_2\text{H}_3\text{O}_2$	201·61
Sulphate	NiO	74·18
Nitric Oxide	$\text{NiSO}_4 + 7\text{H}_2\text{O}$	278·81
Nitroglycerin (<i>see</i> Glyceryl Trinitrate)	NO	29·81
Orthoform	$\text{C}_6\text{H}_5\text{NO}_3$	165·85
Palladous Chloride	PdCl_2	176·06
Paraldehyde	$\text{C}_6\text{H}_{10}\text{O}_3$	131·10
Phenol (Carbolic Acid)	$\text{C}_6\text{H}_5\text{OH}$	93·34
Phenolphthalein	$\text{C}_{20}\text{H}_{14}\text{O}_4$	315·72
Phenylacetamide (<i>see</i> Ace- tanilide)		
Phenyl Salicylate (Salol)	$\text{C}_{13}\text{H}_{10}\text{O}_3$	212·47
Physostigmine	$\text{C}_{13}\text{H}_{21}\text{N}_3\text{O}_2$	273·20
Salicylate	$\text{C}_{13}\text{H}_{21}\text{N}_3\text{O}_2\text{C}_2\text{H}_3\text{O}_3$	410·21
Sulphate	$(\text{C}_{13}\text{H}_{21}\text{N}_3\text{O}_2)_2\text{H}_2\text{SO}_4$	743·75

Picrotoxin	$C_{30}H_{41}O_{13}$	597·74
Pilocarpine	$C_{11}H_{16}N_2O_2$	206·63
Hydrochloride	$C_{11}H_{16}N_2O_2HCl$	242·81
Nitrate	$C_{11}H_{16}N_2O_2HNO_3$	269·20
Piperin	$C_{17}H_{19}NO_3$	283·04
Platinum Chloride (<i>see also</i> Acid, Chloroplatinic)	$PtCl_4$	334·02
Potassium—		
Acetate	$KC_2H_3O_2$	97·44
Arsenite (Metarsenite)	$KAsO_2$	145·02
Benzoate	$KC_6H_5O_2 + 3H_2O$	212·63
Benzoate, Anhydrous	$KC_6H_5O_2$	158·99
Bicarbonate	$KHCO_3$	99·41
Bichromate (<i>see</i> Potas- sium Dichromate)		
Bisulphate	$KHSO_4$	135·21
Bitartrate	$KHC_4H_4O_6$	186·78
Bromate	$KBrO_3$	165·86
Bromide	KBr	118·22
Carbonate	K_2CO_3	137·27
Chlorate	$KClO_3$	121·68
Chloride	KCl	74·04
Chloroplatinate	K_2PtCl_6	482·10
Chromate	K_2CrO_4	192·94
Citrate	$K_3C_6H_5O_7 + H_2O$	322·08
Citrate, Anhydrous	$K_3C_6H_5O_7$	304·20
Cyanide	KCN	64·70
Dichromate	$K_2Cr_2O_7$	292·28
Ferricyanide	$K_3Fe(CN)_6$	327·12
Ferrocyanide	$K_4Fe(CN)_6 + 3H_2O$	419·62
Ferrocyanide, Anhydrous	$K_4Fe(CN)_6$	365·98
Hydroxide	KOH	55·74
Hypophosphite	KPH_2O_2	103·39
Iodide	KI	164·76
Lactate	$KC_3H_5O_3$	127·23
Nitrate	KNO_3	100·43
Permanganate	$KMnO_4$	156·98
Phosphate	K_2HPO_4	173·01
Salicylate	$KC_7H_5O_3$	174·87
Sodium Tartrate	$KNaC_4H_4O_6 + 4H_2O$	280·18
Sodium Tartrate, Anhy- drous	$KNaC_4H_4O_6$	208·66
Sulphate	K_2SO_4	173·07
Sulphite	$K_2SO_3 + 2H_2O$	192·95
Sulphite, Anhydrous	K_2SO_3	157·19
Sulphocyanate (Sulpho- cyanide)	$KSCN$	96·53
Tartrate	$2K_2C_4H_4O_6 + H_2O$	467·16
Tartrate, Anhydrous	$K_2C_4H_4O_6$	224·64
Pyrogallol (Pyrogalllic Acid)	$C_6H_3O_3$	125·10
Quinidine—		
Sulphate	$(C_{20}H_{21}N_2O_2)_2H_2SO_4 + 2H_2O$	776·75
Sulphate, Anhydrous	$(C_{20}H_{21}N_2O_2)_2H_2SO_4$	740·99
Quinine		
Anhydrous	$C_{20}H_{21}N_2O_2 + 3H_2O$	375·46
Bisulphate	$C_{20}H_{21}N_2O_2H_2SO_4 + 7H_2O$	321·82
Bisulphate, Anhydrous	$C_{20}H_{21}N_2O_2H_2SO_4$	544·33
Hydrobromide	$C_{20}H_{21}N_2O_2HBr + H_2O$	419·17
Hydrobromide, Anhy- drous	$C_{20}H_{21}N_2O_2HBr$	420·06
Hydrochloride	$C_{20}H_{21}N_2O_2HCl + 2H_2O$	402·18
Hydrochloride, Acid	$C_{20}H_{21}N_2O_2·2HCl + 3H_2O$	393·76
Hydrochloride, Anhy- drous	$C_{20}H_{21}N_2O_2HCl$	447·82
Salicylate	$2C_{20}H_{21}N_2O_2C_7H_5O_3 + H_2O$	358·00
Sulphate	$(C_{20}H_{21}N_2O_2)_2H_2SO_4 + 7H_2O$	935·54
Sulphate, Anhydrous	$(C_{20}H_{21}N_2O_2)_2H_2SO_4$	866·15
Valerianate	$C_{20}H_{21}N_2O_2C_5H_9O_2 + H_2O$	740·99
		441·01

Resorcinol (Resorcin)	$C_6H_6O_2$	109.22
Saccharin (<i>see</i> Benzoyl-sulphonic-imide)		
Safrol	$C_{10}H_{10}O_2$	160.86
Salicin	$C_{13}H_{18}O_7$	283.99
Salol (<i>see</i> Phenyl Salicylate)		
Santalol	$C_{18}H_{26}O$	220.53
Santonin	$C_{15}H_{18}O_2$	244.29
Scopolamine—		
Hydrobromide	$C_{17}H_{21}NO_4HBr + 3H_2O$	434.92
Hydrobromide, Anhydrous	$C_{17}H_{21}NO_4HBr$	381.28
Silicon Oxide (Silica)	SiO_2	59.96
Silver—		
Chloride	$AgCl$	142.30
Cyanide	$AgCN$	132.96
Iodide	AgI	233.02
Nitrate	$AgNO_3$	168.69
Oxide	Ag_2O	230.12
Sulphate	Ag_2SO_4	309.59
Sulphide	Ag_2S	246.07
Sodium—		
Acetate	$NaC_2H_3O_2 + 3H_2O$	135.10
Acetate, Anhydrous	$NaC_2H_3O_2$	81.46
Arsenate	$Na_3HAsO_4 + 7H_2O$	309.84
Arsenate, Anhydrous	Na_3HAsO_4	184.68
Arsenite (Metarsenite)	$NaAsO_2$	129.04
Benzoate	$NaC_6H_5O_2$	143.01
Bicarbonate	$NaHCO_3$	83.43
Bisulphite	$NaHSO_3$	103.35
Bitartrate	$NaHC_4H_4O_6 + H_2O$	188.68
Borate	$Na_2B_4O_7 + 10H_2O$	379.32
Borate, Anhydrous	$Na_2B_4O_7$	200.52
Bromate	$NaBrO_3$	149.88
Bromide	$NaBr$	102.24
Carbonate	$Na_2CO_3 + 10H_2O$	284.11
Carbonate, Anhydrous	Na_2CO_3	105.31
Carbonate Monohydrated	$Na_2CO_3 + H_2O$	123.19
Chlorate	$NaClO_3$	105.70
Chloride	$NaCl$	58.06
Citrate	$2Na_3C_6H_5O_7 + 11H_2O$	709.20
Citrate, Anhydrous	$Na_3C_6H_5O_7$	256.26
Cobaltic Nitrite	$Co_2(NO_2)_6NaNO_3 + H_2O$	820.56
Dimethylamidoazo - benzene-sulphonate (<i>see</i> Methyl Orange)		
Hydroxide	$NaOH$	39.76
Hypophosphite	$NaPH_2O_2 + H_2O$	105.29
Hyposulphite (<i>see</i> Sodium Thiosulphate)		
Iodide	NaI	148.78
Lactate	$NaC_3H_5O_3$	111.25
Nitrate	$NaNO_3$	84.45
Nitrite	$NaNO_2$	68.57
Nitroprusside	$Na_3Fe(NO)(CN)_5 + 2H_2O$	296.03
Phenolsulphonate(Sulphocarbolate)	$NaC_6H_4O_3S + 2H_2O$	230.45
Phosphate	$Na_2HPO_4 + 12H_2O$	355.61
Phosphate, Anhydrous	Na_2HPO_4	141.05
Pyrophosphate	$Na_2P_2O_7 + 10H_2O$	443.02
Pyrophosphate, Anhydrous	$Na_2P_2O_7$	264.22
Salicylate	$NaC_7H_5O_3$	158.89
Sulphate	$Na_2SO_4 + 10H_2O$	319.91
Sulphate, Anhydrous	Na_2SO_4	141.11
Sulphite	$Na_2SO_3 + 7H_2O$	250.39
Sulphite, Anhydrous	Na_2SO_3	125.23
Sulphocarbolate (<i>see</i> Sodium Phenolsulphonate)		
Tartrate	$Na_2C_4H_4O_6 + 2H_2O$	228.44

Sodium—			
Thiosulphate (Hyposulphite)	$\text{Na}_2\text{S}_2\text{O}_3 + 5\text{H}_2\text{O}$		246·46
Thiosulphate, Anhydrous	$\text{Na}_2\text{S}_2\text{O}_3$		157·06
Sparteine—			
Sulphate	$\text{C}_{18}\text{H}_{28}\text{N}_2\text{H}_2\text{SO}_4 + 5\text{H}_2\text{O}$		419·26
Sulphate, Anhydrous	$\text{C}_{18}\text{H}_{28}\text{N}_2\text{H}_2\text{SO}_4$		329·86
Stannic Chloride	SnCl_4		258·82
Stannous Chloride	$\text{SnCl}_2 + 2\text{H}_2\text{O}$		224·22
Strontium—			
Bromide	$\text{SrBr}_2 + 6\text{H}_2\text{O}$		352·94
Bromide, Anhydrous	SrBr_2		245·66
Carbonate	SrCO_3		146·49
Iodide	$\text{SrI}_2 + 6\text{H}_2\text{O}$		446·02
Iodide, Anhydrous	SrI_2		338·74
Lactate	$\text{Sr}(\text{C}_2\text{H}_3\text{O}_2)_2 + 3\text{H}_2\text{O}$		317·32
Lactate, Anhydrous	$\text{Sr}(\text{C}_2\text{H}_3\text{O}_2)_2$		263·68
Salicylate	$\text{Sr}(\text{C}_7\text{H}_5\text{O}_2)_2 + 2\text{H}_2\text{O}$		394·72
Sulphate	SrSO_4		182·29
Strychnine	$\text{C}_{21}\text{H}_{22}\text{N}_2\text{O}_2$		331·73
Nitrate	$\text{C}_{21}\text{H}_{22}\text{N}_2\text{O}_2\text{HNO}_3$		394·30
Sulphate	$(\text{C}_{21}\text{H}_{22}\text{N}_2\text{O}_2)_2\text{H}_2\text{SO}_4 + 5\text{H}_2\text{O}$		850·21
Sulphate, Anhydrous	$(\text{C}_{21}\text{H}_{22}\text{N}_2\text{O}_2)_2\text{H}_2\text{SO}_4$		760·81
Sugar—			
Cane	$\text{C}_{12}\text{H}_{22}\text{O}_{11}$		339·60
Grape (Glucose)	$\text{C}_6\text{H}_{12}\text{O}_6$		178·74
Milk	$\text{C}_{12}\text{H}_{22}\text{O}_{11} + \text{H}_2\text{O}$		357·48
Sulphonol (Diethylsulphone-dimethylmethane)	$\text{C}_4\text{H}_{10}\text{S}_2\text{O}_4$		226·55
Sulphur Dioxide	SO_2		63·59
Terebene	$\text{C}_{10}\text{H}_{16}$		135·10
Terpin Hydrate	$\text{C}_{10}\text{H}_{18}\text{O}_2 + \text{H}_2\text{O}$		188·74
Tetraiodo-fluorescein (<i>see</i> Iodeosin)			
Tetraiodopyrrol (<i>see</i> Iodol)			
Thiosinamine (Allyl-sulphocarbamide)	$(\text{C}_3\text{H}_5)_2\text{CH}_2\text{N}_2\text{S}$		115·33
Thymol	$\text{C}_{10}\text{H}_{14}\text{OH}$		148·98
Iodide	$\text{C}_{10}\text{H}_{14}\text{OI}_2$		545·76
Tin Salts (<i>see under</i> Stannic and Stannous)			
Trional (Diethylsulphone-methylethylmethane)	$\text{C}_6\text{H}_{10}\text{S}_2\text{O}_4$		240·46
Vanillin	$\text{C}_8\text{H}_8\text{O}_3$		150·92
Water	H_2O		17·88
Zinc—			
Acetate	$\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2 + 2\text{H}_2\text{O}$		217·82
Acetate, Anhydrous	$\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2$		182·06
Bromide	ZnBr_2		223·62
Carbonate (normal)	ZnCO_3		124·45
Chloride	ZnCl_2		135·26
Iodide	ZnI_2		316·70
Oxide	ZnO		80·78
Phenolsulphonate (Sulphocarbonate)	$\text{Zn}(\text{C}_6\text{H}_4\text{O}_2\text{S})_2 + 8\text{H}_2\text{O}$		551·56
Phosphide	Zn_3P_2		256·24
Sulphate	$\text{ZnSO}_4 + 7\text{H}_2\text{O}$		285·41
Sulphate, Anhydrous	ZnSO_4		160·25
Sulphide	ZnS		96·73
Sulphocarbonate (<i>see</i> Zinc Phenolsulphonate)			
Valerianate	$\text{Zn}(\text{C}_5\text{H}_9\text{O}_2) + 2\text{H}_2\text{O}$		301·28

FACTORS FOR QUANTITATIVE ANALYSIS

The weight of substance in the *first* column multiplied by the factor gives the corresponding weight of the substance in the *third* column.

AgCl	0.75277	Ag	AgCN	0.20185	HCN
Ag	1.32843	AgCl	HgS	0.86209	Hg
Ag	1.74080	AgBr	BaSO ₄	0.42088	H ₂ SO ₄
Al ₂ O ₃	0.53015	Al	AgI	0.54029	I
As ₂ S ₃	0.60931	As	K ₂ SO ₄	0.44900	K
Mg ₂ As ₂ O ₇	0.48284	As	K ₂ PtCl ₆	0.16091	K
As ₂ S ₃	0.80430	As ₂ O ₃	Mg ₂ P ₂ O ₇	0.21848	Mg
Mg ₂ As ₂ O ₇	0.63735	As ₂ O ₃	Mn ₂ O ₃	0.72071	Mn
BaSO ₄	0.58783	Ba	Na ₂ SO ₄	0.32438	Na
Bi ₂ O ₃	0.89696	Bi	NaCl	0.39412	Na
AgBr	0.42555	Br	(NH ₄) ₂ PtCl ₆	0.07674	NH ₃
CdS	0.77714	Cd	Pt	0.17441	NH ₃
CaO	0.71429	Ca	PbO	0.92822	Pb
CaCO ₃	0.40000	Ca	PbSO ₄	0.68294	Pb
CO ₂	0.27273	C	Mg ₂ P ₂ O ₇	0.27864	P
AgCl	0.24724	Cl	Sb ₂ S ₃	0.71441	Sb
Cr ₂ O ₃	0.68505	Cr	SiO ₂	0.46703	Si
CuO	0.79823	Cu	SnO ₂	0.78822	Sn
Cu ₂ S	0.79792	Cu	SrSO ₄	0.47668	Sr
Fe ₂ O ₃	0.70000	Fe	BaSO ₄	0.13756	S
H ₂ O	0.11141	H	ZnO	0.80368	Zn
AgCl	0.25423	HCl	ZnS	0.87138	Zn

CHAPTER LVI SOLUBILITY TABLES

S.V.R. = 90 per cent. Alcohol. Glyc. = Glycerin. Chlorof. = Chloroform.

	In Distilled Water		In Other Menstrua
	At 15-5° C.	At 100° C.	
Acetanilide	1 in 190	1 in 18	1 in 4 S.V.R.; 1 in 40 Glyc.
Acid, Agaric	Sparingly	Freely	1 in 180 S.V.R.
Arsenious	1 in 100	1 in 30	1 in 8 Glyc.
Benzole	1 in 420	1 in 12	1 in 32 Glyc.; 1 in 3 S.V.R. or Ether; sol. in fats and oils
Boric	1 in 25	1 in 3	1 in 4 Glyc.; 1 in 30 S.V.R.
Cacodylic	2 in 1	—	1 in 4 S.V.R.
Camphoric	1 in 160	1 in 10	1 in 1½ S.V.R.; 1 in 2 Ether
Carbolic	1 in 13	—	3 in 1 Glyc.; 3 in 1 Chlorof.; 6 in 1 S.V.R.; freely in fats and oils; about 5 per cent. in Soft Paraffin
Chromic	1 in 0.5	—	—
Chrysophanic	Insoluble	Insoluble	Sparingly in S.V.R.; soluble in Ether
Cinnamic	Sparingly	Sparingly	Freely in S.V.R.
Citric	1 in 0.6	—	1 in 2 Glyc.; 1 in 8 Ether
Galic	1 in 105	1 in 3	1 in 6 Glyc.; 1 in 8 S.V.R.
Hippuric	Sparingly	Soluble	Moderately sol. in S.V.R.
Monochloroacetic	Freely	Very freely	Freely in S.V.R. or Ether
Osmic	1 in 13	—	—
Oxalic	1 in 10	1 in 3	—
Picric	1 in 90	—	1 in 10 S.V.R.
Pyrogallie	Freely	—	—
Rosolic	Nearly insol.	—	Moderately sol. in Ether
Salicylic	1 in 550	1 in 9	1 in 195 Glyc.; 1 in 4 S.V.R.; 1 in 2 Ether; 1 in 120 Olive Oil
Succinic	1 in 20	1 in 3	1 in 10 S.V.R.; 1 in 80 Ether
Sulphanilic	1 in 115	—	Insoluble in S.V.R. or Ether
Tannic	All proportions	All proportions	In all proportions in S.V.R. or in Glyc. after warming
Tartaric	1 in 1	—	1 in 5 Glyc.; 1 in 40 Ether; 1 in 3 S.V.R.
Trichloroacetic	Freely	—	Freely in S.V.R. or Ether
Uric	Insoluble	Nearly insol.	Insol. in cold S.V.R. or Ether
Aconitine	Nearly insol.	—	1 in 35 S.V.R.; 1 in 45 Ether; 1 in 1 Chlorof.
Acetol	1 in 15	—	—
Agathin	Insoluble	—	—
Agurin	Freely	—	Freely in S.V.R.
Alcin	1 in 120	Freely	1 in 20 S.V.R.
Alum (Ammonia)	1 in 11	3 in 1	1 in 1½ Glyc.
(Chrome)	1 in 5	1 in 2	—
(Potash)	1 in 11	3 in 1	1 in 3 Glyc.
Aluminium Aceto-Tartrate	1 in 1	—	—
Chloride	2 in 1	—	—
Sulphate	1 in 1½	—	—
Alummol	Freely	—	—
Ammonium Acetate	—	—	Freely in S.V.R.
Benzoate	1 in 5	Very freely	—
Bromide	1 in 1½	—	1 in 15 S.V.R.
Carbonate, B.P.	1 in 4	—	—
Chloride	1 in 3	—	1 in 55 S.V.R.
Citrate	Freely	—	—
Hypophosphite	5 in 6	—	—
Iodide	Freely	—	—
Molybdate	Moderately	—	—
Nitrate	1 in 1	—	—
Oxalate	1 in 24	Freely	—

—	In Distilled Water		In Other Menstrua
	At 15° C.	At 100° C.	
Ammonium Phosphate	1 in 3	1 in 1	—
Plerate	1 in 93	—	—
Salicylate	Freely	—	—
Sulphate	1 in 2	1 in 1	—
Valerianate	Freely	—	Freely in S.V.R.
Ammonol	1 in 110	—	—
Salicylate	1 in 55	—	—
Amyl Nitrite	Insoluble	—	Freely in S.V.R.
Amylene Hydrate	1 in 8	—	—
Amyloform	Insoluble	—	—
Analgen	—	—	—
Anethol	—	—	1 in 3 S.V.R.
Antifebrin, <i>see</i> Acetanilide	—	—	—
Antimony, Tartarated	1 in 17	1 in 2	—
Antipyrin, <i>see</i> Phenazone	—	—	—
Antithermin	Sparingly	Freely	—
Apio	Insoluble	—	Freely in S.V.R.
Apocodine Hydrochloride	Freely	—	Freely in S.V.R.
Apomorphine Hydrochloride	1 in 60	—	1 in 50 S.V.R.; 1 in 100 Glyc.
Arbutin	1 in 8	Freely	1 in 40 S.V.R.
Arecolin Hydrobromide	Freely	—	Freely in S.V.R.
Argonin	Sparingly	Freely	—
Argyrol	Freely	—	—
Aristol	Insoluble	—	Insol. in S.V.R.; sol. in Ether, fats, and oils
Asparagin	1 in 50	—	—
Aspirine	1 in 40	—	—
Atropine	1 in 500	—	1 in 3 S.V.R.; 1 in 25 Ether; 1 in 52 Glyc.; 1 in 15 Oleic Acid
Methyl Bromide	1 in 1	—	1 in 1° S.V.R.
Sulphate	2 in 1	—	1 in 4 S.V.R.
Barium Chlorate	1 in 4	1 in 1½	—
Chloride	1 in 2½	1 in 1½	—
Nitrate	1 in 1½	1 in 3	—
Benzonaphthol	Sparingly	—	Freely in S.V.R.; sparingly in Ether
Berberin Hydrobromide	—	—	Sparingly in S.V.R.
Hydrochloride	—	—	—
Nitrate	—	Freely	—
Phosphate	Freely	—	Sparingly in S.V.R.
Sulphate	Sparingly	—	—
Bismuth Ammonium Citrate	1 in 1	—	—
Benzoate	Insoluble	—	—
Carbonate	—	—	—
Salicylate	—	—	—
Subgallate	—	—	—
Subnitrate	—	—	—
Borax	1 in 25	2 in 1	1 in 1 Glyc.
Bromaltn	Freely	—	—
Bromine	1 in 30	—	Freely in S.V.R. or Ether
Bromipin	Insoluble	—	—
Bruoine	1 in 320	1 in 150	—
Butyl Chloral Hydrate	1 in 37	—	1 in 2 Ether; 1 in 1 S.V.R. or Glyc.; 1 in 20 Olive Oil
Cadmium Acetate	Freely	Freely	Freely in S.V.R.
Bromide	—	—	—
Chloride	—	—	—
Iodide	—	—	—
Sulphate	—	—	—
Caffeine	1 in 68	1 in 1	1 in 40 S.V.R.; 1 in 7 Chlorof.
Benzoate	Moderately	—	—
Citrate	1 in 32	—	1 in 22 S.V.R.
Salicylate	1 in 1	—	—
Sodio-Benzoate	1 in 1	—	—
Sodio-Salicylate	1 in 1	—	—
Calcium Bromide	Freely	Freely	Freely in S.V.R.
Carbonate	Insoluble	—	—
Chlorate	Freely	—	Freely in S.V.R.
Chloride	—	—	—
Glycerophosphate	1 in 22	—	Less soluble in hot water
Hydroxide	1 in 900	—	—
Hypophosphite	1 in 8	—	—
Iodate	1 in 38	—	—
Iodide	Freely	—	Moderately in S.V.R.
Lactate	1 in 10	Freely	Slightly in S.V.R. (only soluble when fresh)
Lactophosphate	1 in 30	—	—
Nitrate	Freely	Freely	Freely in S.V.R.
Oxalate	Insoluble	—	—
Phosphate	Insoluble	—	—
Salicylate	Sparingly	—	—
Sulphate	1 in 500	—	—

SOLUBILITY TABLES—continued

S.V.R. = 90 per cent. Alcohol.

Glyc. = Glycerin.

Chlorof. = Chloroform.

	In Distilled Water		In Other Menstrua
	At 15-5° C.	At 100° C.	
Camphor	1 in 700	—	Very freely in Glacial Acetic Acid, Ether, S.V.R., Chlorof., Oil of Turpentine; 1 in 4 Olive Oil; liquefies on rubbing with Chloral, Thymol, Menthol, or Phenol
Monobromated	Sparingly	—	1 in 12 S.V.R.; 1 in 1 Chlorof.
Cannabin Tannate	Insoluble	—	Sparingly in S.V.R.
Cannabinon	—	—	—
Cantharidin	Nearly insol.	—	1 in 150 Acet. Ether; 1 in 65 Chlorof.; 1 in 40 Acetone
Carmin	Insoluble	—	Soluble in Ammonia and dilute alkalies
Cerium Oxalate	—	—	—
Chinaphehin	Sparingly	—	Freely in S.V.R.
Chinosol	Freely	—	—
Chloral Hydrate	1 in 0.25	—	Very freely in S.V.R., Ether, or Glyc.; liquefies on rubbing with Camphor, Thymol, Phenol, or Menthol
Chloralamide	1 in 24	—	Freely in S.V.R.
Chloralose	1 in 190	Freely	Freely in S.V.R. and Ether
Chloretone	1 in 125	—	Freely in S.V.R.; 1 in 8 Glyc.
Chloroform	1 in 160	—	Freely in S.V.R., Ether, fats, or oils
Cinchonidine	Sparingly	—	1 in 20 S.V.R.
Hydrobromide	1 in 40	Freely	—
Acid	1 in 6	—	—
Hydrochloride	1 in 20	—	—
Acid	Freely	—	—
Salicylate	Sparingly	—	—
Sulphate	1 in 100	—	—
Acid	Freely	—	—
Tannate	Insoluble	—	—
Tartrate	—	—	—
Cinchonine	Sparingly	—	—
Hydrochloride	Freely	—	—
Sulphate	1 in 65	1 in 15	—
Citarin	1 in 2	—	—
Citrophen	1 in 165	—	—
Cobalt Chloride	Freely	—	—
Nitrate	Sparingly	—	—
Sulphate	1 in 24	—	—
Cocaine	1 in 300	—	1 in 10 S.V.R.; 1 in 12 Olive Oil; 1 in 4 Oleic Acid; very freely in Chlorof.
Borate	Freely	—	—
Citrate	—	—	—
Hydrochloride	2 in 1	—	1 in 3 S.V.R.; 1 in 3 Glyc.
Nitrate	Freely	—	—
Salicylate	—	—	Freely in Alcohol
Sulphate	—	—	—
Codeine	1 in 85	1 in 25	1 in 2 S.V.R.; 1 in 30 Ether
Hydrobromide	Freely	—	—
Hydrochloride	1 in 36	—	—
Phosphate	1 in 4	—	—
Sulphate	1 in 34	—	—
Colechicin	Soluble	—	Soluble in S.V.R.
Salicylate	1 in 20	—	—
Collargol	—	—	—
Conine	Sparingly	—	Freely in S.V.R. & Chlorof.
Hydrobromide	Freely	—	Freely in S.V.R.
Copper Acetate	1 in 15	—	—
Ammonio-Sulphate	1 in 2	—	—
Chloride	Freely	—	—
Nitrate	—	—	Freely in S.V.R.
Sulphate	1 in 4	1 in 1	—
Sulphocarbonate	Moderately	—	—
Cotin	Sparingly	—	Soluble in S.V.R. and dilute alkalies
Coumarin	1 in 400	—	Very freely in S.V.R. or Ether
Cresote (Beechwood)	1 in 110	—	In all proportions Alcohol, Ether, Chlorof., Glyc., or Glacial Acetic Acid
Cystamine	1 in 1	—	1 in 8 S.V.R.

	In Distilled Water		In Other Menstrua
	At 15.5° C.	At 100° C.	
Daturine Sulphate	Freely	—	—
Dextroform	Insoluble	—	—
Digitoxin (cryst.)	Insoluble	—	Moderately in Alcohol or Chlorof.
Difiodoform	—	—	—
Dionine	1 in 7	—	1 in 5 S.V.R.
Dithion	1 in 1	—	—
Ekalodoform	—	—	Moderately in S.V.R., Ether, or Chlorof.
Elaterin	—	—	Sparingly in S.V.R.; 1 in 25 Chlorof.
Epicarin	Nearly insol.	—	Freely in S.V.R. or Ether
Erythrol Tetranitrate	Insoluble	—	1 in 60 absolute Alcohol
Eucaine B. Hydrochloride	1 in 40	—	1 in 12 S.V.R.
Lactate	1 in 4	—	1 in 8 S.V.R.
Engallol	Freely	—	—
Euphthalmine	—	—	—
Euquinine	Sparingly	—	Freely in S.V.R.
Europhen	Insoluble	—	Soluble in S.V.R., Chlorof., and oils
Exalgin	1 in 50	1 in 2	1 in 2 S.V.R.
Ferropyrine	Freely	—	—
Fuchaine, <i>see</i> Rosanilin	—	—	—
Gelsemine Hydrochloride	Freely	—	—
Glusidum, <i>see</i> Saccharin	—	—	—
Glutol	Insoluble	—	—
Gold Chloride	Very freely	—	—
and Sodium Chloride	—	—	—
Guaiaacol Benzoate	Insoluble	—	—
Carbonate	—	—	—
Salicylate	—	—	—
Hemalbumin	—	Freely	—
Hematoxylin	Sparingly	—	—
Hedonal	Insoluble	—	—
Helmitol	1 in 5	—	—
Heroin Hydrochloride	Slightly	—	—
Hetraline	1 in 9	—	—
Hexamethylenetetramine	Sparingly	—	Freely in Alcohol
Holocaine Hydrochloride	1 in 50	—	—
Homatropine Hydrobromide	1 in 4	—	Freely in S.V.R.
Hydrochloride	Freely	—	—
Salicylate	—	—	—
Sulphate	—	—	—
Honthin	Insoluble	—	—
Hydraetine	—	—	Freely in S.V.R.
Hydrochloride	Freely	—	—
Hydraetinine	Insoluble	—	—
Hydrochloride	Freely	—	—
Hydroquinone	Nearly insol.	—	—
Hyoscine	Insoluble	—	Freely in S.V.R.
Hydrobromide	2 in 1	—	—
Hydrochloride	1 in 2	—	—
Sulphate	1 in 2	—	—
Hyoscynamine	Insoluble	—	—
Hydrochloride	Freely	—	—
Sulphate	—	—	—
Ichthalbin	Insoluble	—	—
Ichthargan	1 in 6	—	—
Ichthyol Ammon.	Freely	—	Freely in Alcohol, oils and fats, Soft Paraffin, &c.
Iodine	Sparingly	—	1 in 10 S.V.R.; soluble in Ether and Chlorof.
Trichloride	1 in 1	—	—
Iodipin	Insoluble	—	Soluble in Ether, Chlorof., fats, and oils
Iodoform	—	—	1 in 96 S.V.R.; freely in Ether
Iodoformine	—	—	1 in 170 S.V.R.; 1 in 72 Chlorof.
Iodol	—	—	1 in 3 S.V.R.
Iodopyrin	—	Soluble	Soluble in S.V.R.
Iron and Ammonium Citrate	Very sol.	—	Sparingly in S.V.R.
Ammon. Sulphate (ous)	1 in 2	Freely	—
(ic)	1 in 6	—	—
Arsenate	Insoluble	—	—
Benzoate (ic)	—	—	—
Bromide (ous)	Freely	—	—
Chloride (ous)	—	—	—
Citrate	—	—	—
Glycerophosphate	Moderately	—	—
Hypophosphite (ous)	Insoluble	—	—
Iodide (ous)	Freely	—	—
Lactate (ous)	1 in 60	—	—
Oleate (ous)	Insoluble	—	Soluble in fixed oils and fats

SOLUBILITY TABLES—continued

S.V.R. = 90 per cent. Alcohol. Glyc. = Glycerin. Chlorof. = Chloroform.

	In Distilled Water		In Other Menstrua
	At 15.5° C.	At 100° C.	
Iron Oxalate (lc)	Freely	—	—
(ous)	Nearly insol.	—	—
Peptonate	Slightly	Freely	—
Perchloride	Freely	—	—
Pyrophosphate, with Cit- rate of Ammonia	"	"	—
with Citrate of Soda	"	"	—
and Quinine Citrate	Very sol.	—	Sparingly in S.V.R.
Stearate (lc)	Insoluble	—	Soluble in fixed oils and fats
Sulphate (ous)	1 in 2	2 in 1	—
(lc)	Freely	—	—
Itrol	1 in 4,000	—	—
Jalapin	Freely	—	Freely soluble in S.V.R.
Kalrine	1 in 6	—	1 in 20 S.V.R.
Keratin	—	—	Soluble in Ammonia
Kryofin	Sparingly	—	1 in 15 S.V.R.
Lactophenin	1 in 330	—	1 in 9 S.V.R.
Largin	1 in 8	—	—
Lead Acetate	1 in 2	2 in 1	1 in 30
Bromide	Sparingly	Soluble	—
Carbolate	Insoluble	—	—
Carbonate	—	Insoluble	—
Chloride	1 in 140	1 in 30	—
Chromate	Insoluble	—	—
Citrate	Slightly	Freely	—
Iodide	"	1 in 180	—
Nitrate	1 in 2	Freely	—
Oxalate	Insoluble	—	—
Oxide	"	—	—
Peroxide	"	—	—
Phosphate	"	—	—
Salicylate	"	—	—
Subacetate	Freely	—	—
Sulphate	Sparingly	—	—
Sulphide	Insoluble	—	—
Tannate	"	—	—
Thiosulphate	Sparingly	—	—
Lithium Acetate	Very freely	—	—
Benzoate	1 in 14	—	—
Bromide	Very freely	—	—
Caodylate	"	—	—
Carbonate	1 in 70	—	—
Chloride	Very freely	—	—
Citrate	"	—	—
Guaiacate	Freely	—	Freely in S.V.R.
Hippurate	"	—	—
Iodide	Very freely	—	—
Lactate	"	—	—
Phosphate	Sparingly	—	—
Salicylate	1 in 1	—	—
Sulphate	Freely	—	—
Tartarate	"	—	—
Loeophan	Insoluble	—	Freely in Alcohol, Ether, or Chlorof.
Lycetol	Very freely	—	—
Lysidine	"	—	—
Tartarate	"	—	—
Magnesium Acetate	Freely	—	Freely in S.V.R.
Benzoate	1 in 20	—	" "
Boro-citrate	Freely	—	—
Bromide	"	—	—
Carbonate	Insoluble	—	—
Chloride	Freely	—	—
Citrate	"	—	—
Hypophosphite	"	—	—
Iodide	"	—	—
Lactate	1 in 30	—	—
Nitrate	Freely	—	—
Oxide	Sparingly	—	—
Phosphate	"	—	—
Salicylate	1 in 6	—	—
Sulphate	1 in 1.3	3 in 1	—
Sulphite	1 in 100	—	—
Manganese Acetate	1 in 3	Very freely	—
Borate	Very freely	—	—
Bromide	"	—	—
Carbonate	Nearly insol.	—	—
Chloride	Freely	—	—
Citrate	"	—	—

	In Distilled Water		In Other Menstrua
	At 15° C.	At 100° C.	
Manganese Hypophosphite	Freely	—	—
Iodide	"	—	—
Lactate	"	—	—
Oxalate	Nearly insol.	—	—
Phosphate	Insoluble	—	—
Salicylate	Soluble	—	—
Sulphate	1 in 1	—	—
Menthol	Sparingly	—	Freely in Alcohol, Ether, Chlorof., and oils; lique- fies on rubbing with Chloral Hydrate, Phenol
Mercuriol	1 in 100	—	—
Mercury Acetate (lc)	1 in 4	—	—
(ous)	1 in 330	—	—
Ammoniated	Insoluble	—	—
Benzoate (lc)	"	—	—
Bromide (lc)	1 in 80	1 in 5	—
(ous)	Insoluble	—	—
Chloride (lc)	1 in 18	1 in 3	1 in 4 S.V.R.; 2 in 3 Glyc.
Chloride (Calomel)	Insoluble	—	—
Cyanide (lc)	1 in 13	—	—
Glycocholate (lc)	Slightly	—	—
Iodide (lc)	Very sparingly	—	1 in 130 S.V.R.; 1 in 53 Castor Oil; 1 in 223 Olive Oil; 1 in 257 Almond Oil
(ous)	Insoluble	—	—
Nitrate (lc)	Soluble	—	—
(ous)	Insoluble	—	—
Oxide (ous) or (lc)	"	—	—
Oxycyanide	1 in 17	—	—
Phenate	Insoluble	—	—
Phosphate (lc) or (ous)	"	—	—
Salicylate	"	—	—
Sesquiodol	1 in 550	—	—
Snocinnimide	Freely	—	—
Sulphate (lc)	Sparingly	—	—
Sulphide	Insoluble	—	—
Tannate	"	—	—
and Zinc Cyanide	Freely	—	—
Methyl Salicylate	Insoluble	—	Freely in S.V.R.
Methylsulphonal	1 in 320	—	—
Methylene Blue	Soluble	—	—
Migrastin	Freely	—	—
Morphine	Sparingly	—	—
Acetate	1 in 6	—	1 in 100 S.V.R.
Hydrobromide	1 in 25	—	1 in 50 S.V.R.
Hydrochloride	1 in 25	—	1 in 50 S.V.R.
Sulphate	1 in 20	—	1 in 700 S.V.R.
Tartrate	1 in 10	—	1 in 580 S.V.R.
Valerianate	Sparingly	—	—
Mydrine	Freely	—	—
Naphthalene	Sparingly	—	Sparingly in cold, more freely in hot S.V.R.
Naphthol, α-	"	—	Soluble in S.V.R.
β-	"	—	1 in 18 S.V.R.
Narcosine	"	—	In hot S.V.R.
Narcotin	"	—	" "
Nargol	1 in 4	—	—
Nickel Bromide	Freely	—	—
Chloride	"	—	—
Nitrate	"	—	—
Phosphate	"	—	—
Sulphate	"	—	—
Nosophen	Insoluble	—	Insoluble in S.V.R.; soluble in Chlorof.
Orexin Hydrochloride	1 in 15	—	—
Tannate	Insoluble	—	1 in 50 S.V.R.
Orthoform	1 in 2	—	—
New	1 in 450	—	1 in 6 S.V.R.; 1 in 14 Ether
Palladium Chloride	Soluble	Freely	—
Iodide	Insoluble	—	—
Nitrate	Freely	—	—
Sodium Chloride	"	—	—
Pancreatin	Soluble	—	—
Papaverin	Insoluble	—	—
Paraldehyde	1 in 10	—	Freely in S.V.R.
Pelletierine	Insoluble	—	—
Tannate	1 in 700	—	—
Pepein Scales	Soluble	—	—
Peptone	Freely	—	—
Peronine	1 in 2	—	1 in 160 S.V.R.
Phenacetin	Insoluble	About 1 in 100	1 in 21 S.V.R.

SOLUBILITY TABLES—continued

S.V.R. = 90 per cent. Alcohol. Glyc. = Glycerin. Chlorof. = Chloroform.

—	In Distilled Water		In Other Menstrua
	At 15-5° C.	At 100° C.	
Phenazone	1 in 1½	—	1 in 1½ S.V.R.
Salicylate	1 in 255	—	—
Phenocoll Hydrochloride	1 in 20	Very freely	Freely in S.V.R.
Phenol, <i>see</i> Acid, Carbolle			
Phenolphthalein	Nearly insol.	Nearly insol.	1 in 10 S.V.R.
Phenylenediamine μ Hydrochl.	Soluble	Freely	—
Meta Sulph.	"	"	—
Phenylhydrazin Hydrochlor.	Soluble	"	Soluble in S.V.R.
Phloridzin	Insoluble	—	1 in 4 S.V.R.
Phloroglucin	1 in 100	—	Soluble in S.V.R. and Ether
Phosphorus	Insoluble	Insoluble	1 in 25 Chlorof.; 1 in 1 Carbon Disulphide: about 1 in 100 fats and fixed oils; 1 in 200 Ether; 1 in 840 S.V.R.
Physostigmine	Nearly insol.	—	Freely in S.V.R.
Hydrobromide	Freely sol.	—	" "
Hydrochloride	—	—	" "
Salicylate	1 in 130	—	" "
Sulphate	4 in 1	—	" "
Pilocarpine	Nearly insol.	—	" "
Hydrobromide	Freely sol.	—	" "
Hydrochloride	—	—	" "
Nitrate	"	—	" "
Salicylate	"	—	" "
Sulphate	"	—	" "
Piperazine	"	—	" "
Quinate	"	—	" "
Salicylate	"	—	" "
Piperidin Tartrate	"	—	—
Platinic Chloride	Freely	Freely	Soluble in S.V.R.
Potassium Acetate	2 in 1	—	1 in 2 S.V.R.
Arsenate	1 in 5	Freely	—
Arsenite	Freely	"	—
Benzoate	"	"	Freely in S.V.R.
Bicarbonat	2 in 7	—	—
Bichromate	1 in 10	1 in 2	—
Borate	Freely	Freely	—
Bromate	1 in 16	—	—
Bromide	1 in 2	"	1 in 200 S.V.R.
Cocodylate	Freely	—	—
Carbonate	4 in 3	—	—
Chlorate	1 in 16	1 in 2	1 in 170 S.V.R.
Chloride	1 in 3	Very freely	—
Chromate	1 in 2	"	—
Cinnamate	Soluble	—	—
Citrate	Freely	—	Sparingly in S.V.R.
Cyanide (99 per cent.)	1 in 2	—	—
Ferricyanide	1 in 3	1 in 1½	—
Ferrocyanide	1 in 4	1 in 2	—
Fluoride	Freely	Freely	—
Glycerophosphate	Very freely	—	—
Hydrosulphide	Freely	Freely	Freely in S.V.R.
Hydroxide	2 in 1	—	—
Hypophosphite	2 in 1	—	1 in 8 S.V.R.
Iodate	1 in 13	—	1 in 8 S.V.R.
Iodide	4 in 3	—	1 in 12 S.V.R.
Nitrate	1 in 4	2 in 1	—
Nitrite	Very freely	—	—
Nitro-prusside	Freely	—	Soluble in S.V.R.
Oleate	Soluble	—	—
Oxalate	1 in 3	Very freely	" "
Bi-	1 in 40	1 in 6	—
Perchlorate	Sparingly	—	—
Permanganate	1 in 17	1 in 3	—
Persulphate	Slightly	—	—
Phosphate	Freely	—	—
Bi-	Soluble	—	—
Pyro-	Freely	—	—
Salicylate	"	—	—
Silicate	—	Freely	—
Sozolodol	1 in 50	—	—
Stearate	Sparingly	Freely	—
Sulphate	1 in 10	—	—
Sulphide	1 in 3	—	—
Tartrate	5 in 3	—	—
Acid	1 in 200	—	—
Thiosulphate	Freely	—	—
Protargol	1 in 2	—	—
Pyoktannin, Blue	Soluble	Freely	Soluble in S.V.R.

	In Distilled Water		In Other Menstrua
	At 15.5° C.	At 100° C.	
Pyoktannin, Yellow	Sparingly	Freely	Soluble in S.V.R.
Pyridine Citrate	Soluble	"	" "
Nitrate	"	"	" "
Sulphate	"	"	" "
Quassin Cryst.	Sparingly	"	"
Quinidine	Insoluble	"	"
Bisulphate	1 in 8	"	"
Quinine	Nearly insol.	"	1 in 6 S.V.R.
Arsenate	Sparingly	Freely	"
Arsenite	1 in 150	"	"
Benzoate	1 in 350	"	"
Carbonate	Sparingly	"	"
Citrate	1 in 1,300	1 in 30	1 in 45 S.V.R.
Glycerophosphate	1 in 200	"	1 in 200 S.V.R.
Hydrobromide	1 in 55	Freely	Freely in Alcohol
Acid	1 in 7	"	" "
Hydrochloride	1 in 40	"	" "
Acid	4 in 3	"	1 in 5 S.V.R.; 1 in 7 Chlorof.
Hydroiodide	Sparingly	"	"
Hypophosphite	1 in 70	1 in 15	"
Lactate	1 in 3	1 in 1	Freely in S.V.R.
Oxalate	Nearly insol.	"	"
Phenate	1 in 400	"	1 in 80 S.V.R.
Phosphate	1 in 700	"	"
Quinate	1 in 5	"	1 in 10 S.V.R.
Salicylate	1 in 230	"	1 in 20 S.V.R.
Sulphate	1 in 800	1 in 25	1 in 65 S.V.R.
Sulphocarbolate	Sparingly	"	Freely in S.V.R.
Tannate	"	"	1 in 3 S.V.R.
Tartrate	"	"	"
Valerianate	1 in 60	"	"
Resorcin	Soluble	Freely	1 in 1 S.V.R.; freely in Ether; 1 in 25 Olive Oil
Rosanilin Acetate	Freely	"	Freely in S.V.R.
Hydrochloride	Sparingly	"	"
Rubidium Bromide	Freely	Very freely	"
Chloride	"	"	"
Iodide	"	"	"
Nitrate	"	"	"
Sulphate	"	"	"
Saccharin	1 in 375	1 in 30	1 in 38 S.V.R.; freely sol. in dilute alkalis
Salacetol	Sparingly	"	1 in 15 S.V.R.
Salicin	1 in 29	Freely	1 in 80 S.V.R.
Saligenin	1 in 15	"	Freely in S.V.R.
Salipyrine	Sparingly	"	Freely in S.V.R.
Salocoll	Freely	"	"
Salol	Sparingly	"	1 in 12 S.V.R.; 2 in 1 Ether; 1 in 12 Liquid Paraffin or fixed oils
Salophen	Sparingly	"	Freely in S.V.R.
Saloquinine	"	"	Soluble in S.V.R.
Salicylate	"	"	1 in 32 S.V.R.
Santonin	Sparingly	1 in 250	1 in 62 S.V.R.
Scopolamine, see Hyoscin	"	"	"
Silver Chloride	Insoluble	Insoluble	Sol. in Ammonia, KCN, and 'Hypo' solution
Cyanide	"	"	"
Nitrate	2 in 1	Very freely	1 in 18 S.V.R. " "
Sodium Acetate	"	2 in 1	1 in 23 S.V.R.
Arsenate	1 in 4	Very freely	"
Arsenite	Freely	"	"
Benzoate	1 in 3	"	"
Bicarbonate	1 in 12	"	"
Bichromate	Freely	"	"
Bromate	1 in 3	"	"
Bromide	5 in 6	"	"
Cacodylate	2 in 1	"	1 in 1 S.V.R.
Carbonate	5 in 8	"	"
Chlorate	1 in 4	"	"
Chloride	1 in 3	"	"
Cinnamate	1 in 11	"	"
Cyanide	Freely	"	"
Ethylate	Very freely	"	Very freely
Fluoride	1 in 25	"	"
Glycerophosphate	Very freely	"	"
Hydrosulphide	"	"	"
Hydroxide	"	"	Freely in S.V.R.
Hypophosphite	1 in 1	"	Soluble in S.V.R.
Iodate	1 in 15	"	"
Iodide	2 in 1	"	1 in 4 S.V.R.
Lactate	Freely	"	"
Nitrate	Very freely	"	"

SOLUBILITY TABLES—continued

S.V.R. = 90 per cent. Alcohol. Glyc. = Glycerin. Chlorof. = Chloroform.

	In Distilled Water		In Other Menstrua
	At 15° C.	At 100° C.	
Sodium Nitrite	5 in 6	—	—
Nitroprusside	Freely	—	—
Oleate	Soluble	Very freely	Soluble in S.V.R.
Oxalate	1 in 33	—	—
Permanganate	Very freely	—	—
Peroxid.	Soluble	—	It is decomposed by water
Persulphate	"	—	—
Phosphate	1 in 6	—	—
Bi-	Soluble	—	—
Pyro-	1 in 12	—	—
Salicylate	1 in 1	—	—
Sesquiodol	1 in 12	—	—
Stearate	Soluble	Very freely	—
Sulphate	1 in 3	—	—
Bi-	Very freely	—	—
Sulphide	"	Very freely	—
Sulphite	10 in 13	—	—
Bi-	Very freely	—	—
Sulphocarbonate	1 in 6	—	—
Tartrate	1 in 2	—	—
Potassium Tart.	1 in 1	—	—
Taurocholate	2 in 1	—	—
Thiosulphate	1 in 1	—	—
Tungstate	Freely	—	—
Valerianate	"	—	—
Vanadate, Meta-	2 in 1	—	—
Ortho-	1 in 1	—	—
Sparteine	Insoluble	—	—
Hydrochloride	Freely	—	Freely in S.V.R.
Sulphate	2 in 1	—	1 in 5 S.V.R.
Strontium Acetate	Soluble	Freely	—
Bromate	1 in 3	—	—
Bromide	1 in 1	"	—
Carbonate	Insoluble	—	—
Chlorate	1 in 1	—	—
Chloride	1 in 2	—	—
Cinnamate	1 in 100	—	—
Citrate	Sparingly	—	—
Iodide	1 in 1	—	—
Lactate	1 in 4	—	—
Nitrate	1 in 5	—	—
Phosphate	Insoluble	—	—
Salicylate	Soluble	—	—
Sulphate	Insoluble	—	—
Sulphide	"	—	—
Strophanthin	Soluble	—	—
Strychnine	Nearly insol.	—	1 in 170 S.V.R.; 1 in 250 Alcohol 70 per cent.; 1 in 400 Alcohol 60 per cent.; 1 in 800 Alcohol 45 per cent.; 1 in 4,200 Alcohol 20 per cent.
Hydrobromide	1 in 65	—	1 in 65 S.V.R.
Hydrochloride	1 in 35	—	1 in 50 S.V.R.
Nitrate	1 in 63	—	1 in 70 S.V.R.
Sulphate	1 in 48	—	1 in 110 S.V.R.
Sulphonat	1 in 450	1 in 20	1 in 80 S.V.R.
Sulphur	Insoluble	—	Soluble in Carbon Disulphide
Tannalbin	"	—	—
Tannigen	"	—	—
Tannoform	"	—	—
Tanocol	"	—	—
Terpene Hydrate	1 in 250	—	1 in 14 Alcohol 90 per cent.; 1 in 45 Alcohol 60 per cent.
Tetronal	1 in 550	—	1 in 12 Alcohol 90 per cent.
Thallin Salicylate	—	—	Soluble in Alcohol 90 per cent.
Sulphate	1 in 7	2 in 1	—
Theobromine	1 in 1,700	—	Very sparingly
Hydrochloride	Decomposes	—	—
Salicylate	Sparingly	—	—
Sodium Benzoate	1 in 2	Very freely	—
Salicylate	1 in 2	"	—
Theocin	1 in 190	—	1 in 80 S.V.R.
Thiocol	1 in 6	—	1 in 390 S.V.R.
Thioform	Insoluble	—	—
Thiol	Nearly insol.	Soluble	—
Thiophene Iodide	Insoluble	—	—
Thiosinamine	1 in 17	—	1 in 2 S.V.R.

—	In Distilled Water		In Other Menstrua
	At 15-5° C.	At 100° C.	
Thymol	Very sparingly	—	3 in 1 S.V.R.; liquefies with Chloral, Phenol, or Camphor
Trichlorphenol	Insoluble	—	Soluble in S.V.R.
Trional	1 in 320	—	1 in 11 S.V.R.
Tussol	Freely	Very freely	—
Uranium Acetate	"	"	—
Nitrate	"	"	—
Sulphate	"	"	—
Urea	1 in 1	—	1 in 7 S.V.R.
Urethane	1 in 10	—	—
Uricedlin	Freely	—	—
Urol	"	—	—
Urocin	1 in 2	—	—
Vanillin	Sparingly	—	Freely in S.V.R.
Veratrine	Very sparingly	—	" "
Veronal	1 in 160	—	1 in 9 S.V.R.
Zinc Acetate	1 in 3	1 in 1½	1 in 36 S.V.R.
Bromide	Freely	—	—
Carbonate	Insoluble	—	—
Chloride	2 in 1	—	—
Cyanide	Insoluble	—	Soluble in Ammonia
Iodide	Freely	Very freely	—
Lactate	1 in 60	1 in 6	—
Nitrate	Soluble	Very freely	—
Oxalate	Sparingly	—	—
Oxide	Insoluble	—	—
Permanganate	Very freely	—	—
Phosphate	Insoluble	—	—
Salicylate	1 in 25	Freely	—
Sesquiodol	1 in 20	—	—
Sulphate	10 in 7	—	—
Sulphide	Insoluble	—	—
Sulphite	Sparingly	—	—
Sulphocarbonate	1 in 3	—	—
Valerianate	1 in 90	—	—

CHAPTER LVII

SYNONYMS

Acetylphenylamine	<i>Acetanilide</i>
Acid, Borussic	<i>Acid Hydrocyanic Dilute</i>
Acid, Carbazotic	<i>Picric Acid</i>
Acid, Phenic	<i>Carbolic Acid</i>
Acid of Sugar	<i>Oxalic Acid</i>
Acidum Ossium	<i>Phosphoric Acid</i>
Acid. Scyto-depsicum	<i>Tannic Acid</i>
Adeps Anserinus	<i>Goose Grease</i>
Adeps Gadi	<i>Cod Liver Oil</i>
Adeps Ovillus	<i>Mutton Suet</i>
Adragante	<i>Tragacanth</i>
Aerosus Lapis	<i>Calamine</i>
Ærugo	<i>Verdigris</i>
Aes	<i>Copper</i>
Æthiops Absorbens	<i>Hydrarg. cum Creta</i>
Æthiops Antimonialis	<i>A mixture of Black Antimony and Mercury</i>
Æthiops Martialis	<i>Black Iron Oxide</i>
Æthiops Mineral	<i>Hydrarg. Sulph. cum Sulph.</i>
Alcoôlat	<i>Alcohol</i>
Alegar	<i>Vinegar</i>
Algaroth's Powder	<i>Antimony Oxychloride</i>
Alum Rupeum	<i>Alum with Ferric Oxide</i>
Alumen Plumosum	<i>Asbestos</i>
Ambretta Seeds	<i>Musk Seeds</i>
Amianthus	<i>Asbestos</i>
Amidum	<i>Starch</i>
Amphion	<i>Opium</i>
Analgesine	<i>Phenazone</i>
Annidalin	<i>Aristol</i>
Antimony, Diaphoretic	<i>Antimony Oxide</i>
Antlia Gastrica	<i>Stomach Pump</i>
Aqua Ammoniac	<i>Liquor Ammoniac</i>
Aqua Coloniensis	<i>Eau de Cologne</i>
Aqua Flava	<i>Lotio Hydrarg. Flav.</i>
Aqua Fortis	<i>Nitric Acid</i>
Aqua Naphæ	<i>Orange Flower Water</i>
Aqua Nigra	<i>Lotio Hydrarg. Nig.</i>
Aqua Regia	<i>Strong Nitro-hydrochloric Acid</i>
Aqua Vitæ	<i>Brandy</i>
Aquila Alba	<i>Calomel</i>
Argentum Vivum	<i>Mercury</i>
Argol	<i>Crude Cream of Tartar</i>
Aromatic Confection	<i>Pulv. Cretæ Aromat.</i>
Asa Dulcis	<i>Benzoin</i>
Atramentum	<i>Black Ink</i>
Aurum Musivum	<i>Tin Sulphide (Mosaic Gold)</i>
Axungia	<i>Lard</i>
Baker's Salt	<i>Ammon. Carb.</i>
Balsam, Friar's	<i>Comp. Tincture of Benzoin</i>
Balsam, Persian	<i>Comp. Tincture of Benzoin</i>
Balsam of Sulphur	<i>Sulphurated Oil</i>
Balsam, Traumatic	<i>Tr. Benz. Co.</i>

Basilicon Ointment	<i>Resin Ointment</i>
Baume de Vie	<i>Dec. Aloes Co.</i>
Benzene	<i>Coal Tar distillate</i>
Benzin	<i>Petroleum distillate</i>
Benzol	<i>Synonym for Benzene</i>
Betel Nut	<i>Areca Nut</i>
Bitter Apple	<i>Colocynth</i>
Bitter Chips	<i>Quassia</i>
Black Draught	<i>Mist. Sennae Co.</i>
Black Drop	<i>A strong sol. of Opium (U.S.P. 1851)</i>
Blaud's Pill	<i>Pil. Ferri</i>
Blue, Berlin	<i>Prussian Blue</i>
Blue Ointment	<i>Ung. Hydrarg.</i>
Blue Pill	<i>Pil. Hydrarg.</i>
Blue Stone	<i>Cuprio Sulphate</i>
Blue Uction	<i>Ung. Hydrarg. Mite</i>
Bole Armenian	<i>Ferrio Oxide</i>
Brassium	<i>Malt</i>
British Gum	<i>Dextrin</i>
Butter of Antimony	<i>Liq. Antim. Chlor.</i>
Butter of Zinc	<i>Zinc Chloride</i>
Byne	<i>Malt</i>
Cacao Butter	<i>Oil of Theobroma</i>
Calisaya Bark	<i>Yellow Cinchona Bark</i>
Camphor Julep	<i>Camphor Water</i>
Caramel	<i>Burnt Sugar</i>
Carbasus	<i>Gauze</i>
Carron Oil	<i>Linimentum Calcis</i>
Cera Sigillata	<i>Sealing Wax</i>
Ceratum Galeni	<i>Cold Cream</i>
Ceresin	<i>A kind of Hard Paraffin</i>
Cerussa	<i>Lead Carbonate</i>
Charpie	<i>Lint</i>
Chemical Food	<i>Syr. Ferri Phosph. Co.</i>
Chinese White	<i>Zinc Oxide</i>
Chinium	<i>Quinine</i>
Chymosin	<i>Pepsin</i>
Cinnabar	<i>Vermilion</i>
Cinnabar of Antimony	<i>Vermilion</i>
Citrine Ointment	<i>Ung. Hydrarg. Nitratis</i>
Colcothar	<i>Purple Ferrio Oxide</i>
Colophony	<i>Resin</i>
Commander's Balsam	<i>Tinct. Benzoin. Co.</i>
Conf. Aromat.	<i>Pulv. Cretæ Aromat.</i>
Copperas	<i>Ferrous Sulphate (impure)</i>
Cornu Cervi	<i>Hartshorn</i>
Corrosive Sublimate	<i>Mercurio Chloride</i>
Cosmetic Bismuth	<i>Bismuth Oxychloride</i>
Cosmetic Mercury	<i>Ammoniated Mercury</i>
Crabs' Eyes	<i>A preparation of Calcium Carbonate</i>
Cream of Tartar	<i>Potass. Tart. Acidus</i>
Crocus Martis	<i>Colcothar (Purple Ferrio Oxide)</i>
Crocus Saturni	<i>Red Lead</i>
Crow-Fig	<i>Nux Vomica</i>
Cuca	<i>Coca</i>
Cutch	<i>Black Catechu</i>
Dactyli	<i>Dates</i>
Deadly Nightshade	<i>Belladonna</i>
Diachylon Plaster	<i>Emp. Plumbi</i>
Donovan's Solution	<i>Liq. Arsenii et Hydrargyri Iodidi</i>
Dover's Powder	<i>Pulv. Ipecac. Co.</i>
Draco Mitigatus	<i>Calomel</i>
Dragon's Blood	<i>Calamus Draco</i>
Dutch Drops	<i>Haarlem Oil</i>
Earth, Japan	<i>Catechu</i>
Easton's Syrup	<i>Syr. Ferri Phosph. c. Quin. et Strych.</i>
Eau de Javelle	<i>Sol. Potass. Chlorinat.</i>
Eau de Luce	<i>Tinct. Ammon. Co. P.L.</i>

Eau de Naphre	<i>Aq. Flor. Aurant.</i>
Eau de Vie	<i>Brandy</i>
Ebor Ustum	<i>Bone Black</i>
Elixir of Paregoric	<i>Tinct. Camph. Co.</i>
Elixir of Vitriol	<i>Acid. Sulph. Aromat.</i>
Ens Martis	<i>Ferri Ammon. Cit.</i>
Epsom Salt	<i>Magnesium Sulphate</i>
Eyestones	<i>Crabs' Eyes</i>
Fecula	<i>Starch</i>
Ferrugo	<i>Iron Rust</i>
Ferrum Limatum	<i>Iron Filings</i>
Ferrum Pomatum	<i>Iron Malate</i>
Flake White	<i>Lead Carbonate</i>
Flores Antimonii	<i>Antimony Sesquioxide</i>
Flores Benzoës	<i>Benzoic Acid</i>
Flores Bismuthi	<i>Bismuth Oxide</i>
Flores Zinci	<i>Zinc Oxide</i>
Flos Æruginis	<i>Copper Acetate</i>
Flos Salis	<i>Sodium Carbonate</i>
Flowers of Sulphur	<i>Sublimed Sulphur</i>
Flowers of Zinc	<i>Zinc Oxide</i>
Fluid Magnesia	<i>Liq. Magnes. Carb.</i>
Fowler's Solution	<i>Liq. Arsenicalis</i>
Frankincense	<i>Olibanum ; Thus</i>
French White	<i>Powdered Talc</i>
Friar's Balsam	<i>Tinct. Benzoin. Co.</i>
Furfur	<i>Bran</i>
Galena	<i>Lead Sulphide</i>
Glass of Antimony	<i>Vitrified Antimony Oxide</i>
Glass Gall	<i>The scum formed on the surface of melting glass</i>
Glauber's Salt	<i>Sodium Sulphate</i>
Glonoin Sol.	<i>Liq. Trinitrini</i>
Goulard's Extract	<i>Liq. Plumbi Fortis</i>
Goulard's Water	<i>Liq. Plumbi Dil.</i>
Grains of Paradise	<i>Melaguetta Pepper</i>
Green Ointment	<i>Ung. Sambuci Virid.</i>
Green Vitriol	<i>Ferrous Sulphate (Impure)</i>
Gregory's Powder	<i>Pulv. Rhei Co.</i>
Griffith's Mixture	<i>Mist. Ferri Co.</i>
Gum Dragon	<i>Tragacanth</i>
Gum Scorpionis	<i>Acacia</i>
Heberden's Ink	<i>Mist. Ferri Aromat.</i>
Hepar Sulphur	<i>Potassa Sulphurata</i>
Hiera Picra	<i>Pulv. Aloes cum Canella</i>
Hoffmann's Anodyne	<i>Sp. Ætheris Comp.</i>
Homberg's Phosphorus	<i>Calcium Chloride</i>
Homberg's Sedative Salt	<i>Boric Acid</i>
Huile de Cade	<i>Juniper Tar Oil</i>
Huxham's Tincture	<i>Tinct. Cinchone Co.</i>
Ichthyocolla	<i>Isinglass</i>
Issue Peas	<i>Orange Berries</i>
James's Powder	<i>Said to be Pulv. Antimonialis</i>
Japan Earth	<i>Catechu</i>
Jesuit's Bark	<i>Cinchona</i>
Jesuit's Drops	<i>Tinct. Benz. Co.</i>
Jew's Pitch	<i>Asphaltum</i>
Kali Æratum	<i>Potassium Carbonate</i>
Kaolin	<i>China Clay</i>
Kefyr	<i>A fermented milk</i>
Kermes Mineral	<i>Sulphurated Antimony</i>
King's Yellow	<i>Antimony Sulphide</i>
Labarraque's Liquid	<i>Liq. Calcis Chlorinata</i>
Lamotte's Drops	<i>Tr. Ferri Perchlor. Æther.</i>
Lanain	<i>Adeps Lane Hyd.</i>
Lapis Baptista	<i>Talc</i>
Lapis Ceruleus	<i>Copper Sulphate</i>
Lapis Infernalis	<i>Silver Nitrate (Fused)</i>
Lapis Lazuli	<i>Ultramarine</i>

Lapis Smiridis	<i>Emery</i>
Laudanum	<i>Tinct. Opii</i>
Lavender Drops	<i>Tinct. Lavand. Co.</i>
Lenitive Electuary	<i>Conf. Sennæ</i>
Leucænus	<i>White Wine</i>
Lignum Sanctum	<i>Guaiacum Wood</i>
Lignum Vitæ	<i>Guaiacum Wood</i>
Liquor Cornu Cervi	<i>Liquor Ammoniac</i>
Liquor Donovanii	<i>See Donovan's</i>
Liquor Potassæ Arsenitis	<i>Liquor Arsenicalis</i>
Liquor Seriparus	<i>Liquid Rennet</i>
Litharge	<i>Lead Oxide</i>
Liver of Sulphur	<i>Sulphurated Potash</i>
Lugol's Solution	<i>Liq. Iodi, B.P. 1885</i>
Lunar Caustic	<i>Nitrate of Silver</i>
Magisterium Coccionellæ	<i>Carmine</i>
Magistery of Bismuth	<i>Bismuth Oxynitrate</i>
Magistery of Sulphur	<i>Washed Sulphur</i>
Magnesia Alba	<i>Magnes. Carb. Pond.</i>
Magnesia Nigra	<i>Manganese Dioxide</i>
Marine Acid	<i>Hydrochloric Acid</i>
Marine Salt	<i>Sodium Chloride</i>
Massicot	<i>Lead Oxide; Litharge</i>
Maw Seed	<i>Poppy Seed</i>
Medulla Bovis	<i>Beef Marrow</i>
Mercurius Dulcis	<i>Calomel</i>
Mica Panis	<i>Bread Crumb</i>
Microcosmic Salt	<i>Na(NH₄)HPO₄</i>
Milk of Sulphur	<i>Precipitated Sulphur</i>
Mindererus Spirit	<i>Liq. Ammon. Acet.</i>
Mineral, Æthiops	<i>See Æthiops</i>
Mineral Gum	<i>Soluble Glass</i>
Mineral, Kermes	<i>See Kermes</i>
Mineral, Turpeth	<i>See Turpeth</i>
Ninium	<i>Red Lead</i>
Mistura Acaciæ	<i>Mucilage of Acacia</i>
Mosaic Gold	<i>See Aurum</i>
Muriatic Acid	<i>Hydrochloric Acid</i>
Natrium	<i>Sodium</i>
Natro-Kali Tartaricum	<i>Rochelle Salt</i>
Natron	<i>Sodium</i>
Neogale	<i>Fresh Milk</i>
Nitre	<i>Potassium Nitrate</i>
Oil, Carron	<i>See Carron</i>
Oil of Dagget	<i>Oil of Birch Tar</i>
Oil, Dippel's	<i>Animal oil distilled from bones</i>
Oil of Kermes	<i>Syr. Rhus</i>
Oil, Lund's	<i>A mixture of Almond and Castor Oils with 5 per cent. Phenol</i>
Oil of Mace	<i>Expressed Oil of Nutmeg</i>
Oil of Smoke	<i>Creosote</i>
Oil of Swallows	<i>Ol. Sambuci Virid.</i>
Oil of Tar	<i>Creosote</i>
Oil of Tartar	<i>Sol. of Potass. Carb.</i>
Oil of Vitriol	<i>Sulphuric Acid</i>
Ointment, Basilicon	<i>See Basilicon</i>
Ointment, Citrine	<i>See Citrine</i>
Ointment, Green	<i>See Green</i>
Oleum Anthos	<i>Oil of Rosemary</i>
Oleum Bubulum	<i>Neatsfoot Oil</i>
Oleum Cedræ	<i>Oil of Lemon</i>
Oleum Cocois	<i>Coco-nut Oil</i>
Oleum Napi	<i>Rape Oil</i>
Oleum Nervinum	<i>Neatsfoot Oil</i>
Oleum Palmæ Christi	<i>Castor Oil</i>
Oleum Petræ	<i>Crude Petroleum</i>
Oleum Portugallicum	<i>Oil of Bergamot</i>
Oleum Rusci	<i>Oil of Birch Tar</i>

Oleum Viride	<i>Ol. Sambuci Viride</i>
Opodeldoc	<i>Lin. Saponis Comp.</i>
Orpiment	<i>Yellow Arsenic Sulphide (native)</i>
Panacea Mercurialis	<i>Calomel</i>
Paregoric	<i>Tinct. Camphor. Co.</i>
Paris Green	<i>Copper Arsenite</i>
Passulæ	<i>Raisins</i>
Pearl White	<i>Bismuth Oxynitrate</i>
Persio	<i>Cudbear</i>
Phenic Acid	<i>Carbolic Acid</i>
Phenylic Acid	<i>Carbolic Acid</i>
Pill, Bland's	<i>Pil. Ferri</i>
Pill, Christison's	<i>Pil. Coloc. et Hyoscyami</i>
Pill, Marshall Hall's	<i>Pil. Aloes Dil.</i>
Pil. Plummeri	<i>Pil. Hydrarg. Subchlor. Co.</i>
Pil. Rufi	<i>Pil. Aloes et Myrrhæ</i>
Pinguedo	<i>Lard</i>
Plasma	<i>Glycerin of Starch</i>
Pompeian Ointment	<i>Ung. Sambuci Virid.</i>
Pompholix	<i>Zinc Oxide</i>
Precipitate, Red	<i>Hyd. Oxid. Rub.</i>
Precipitate, White	<i>Hyd. Ammoniatum</i>
Pulvis Aërophorus	<i>Seidlitz Powders</i>
Pulvis Jacobi Fict.	<i>Pulvis Antimonialis</i>
Putty Powder	<i>Tin Oxide</i>
Pyrænus	<i>Alcohol</i>
Ramenti Ferri	<i>Iron Filings</i>
Realgar	<i>Native Red Arsenic Sulphide</i>
Red Dominion Plaster	<i>Emp. Ferri</i>
Red Lavender Drops	<i>Tinct. Lavand. Co.</i>
Roche Alum	<i>Alum coloured with Ferric Oxide</i>
Rochelle Salt	<i>Soda Tartarata</i>
Roman Alum	<i>Roche Alum</i>
Roman Vitriol	<i>Cupric Sulphate</i>
Rufus Pill	<i>Pil. Aloës et Myrrhæ</i>
Rupel Alum	<i>Roche Alum</i>
Sal Absinthii	<i>Potassium Carbonate</i>
Sal Acetosella	<i>Potassium Oxalate</i>
Sal Aëratus	<i>Potassium Carbonate</i>
Sal Alembroth	<i>Chloride of Ammonium and Mercury</i>
Sal Ammoniac	<i>Ammonium Chloride</i>
Sal Ammoniacum Martiale	<i>Iron Ammonium Chloride</i>
Sal Argentum	<i>Silver Nitrate</i>
Sal Benjamin	<i>Benzoic Acid</i>
Sal Catharticus Amarus	<i>Magnesium Sulphate</i>
Sal Chalybis	<i>Ferrous Sulphate</i>
Sal Cornu Cervi	<i>Ammon. Carb.</i>
Sal Diureticus	<i>Potassium Acetate</i>
Sal de Duobus	<i>Potassium Sulphate</i>
Sal Enixum	<i>Potassium Hydrogen Sulphate</i>
Sal Fossilis	<i>Common Salt</i>
Sal Fuliginis	<i>Ammonium Carbonate</i>
Sal Marinum	<i>Sea Salt; Common Salt</i>
Sal Martis	<i>Ferrous Sulphate</i>
Sal Nitrum	<i>Saltpetre</i>
Sal Polychrestus	<i>Potassium Sulphate</i>
Sal Prunella	<i>Potassium Nitrate</i>
Sal Rupellensis	<i>Rochelle Salt</i>
Sal Saturni	<i>Lead Acetate</i>
Sal Sedativus (Homberg)	<i>Boric Acid</i>
Sal Tartari	<i>Potassium Carbonate</i>
Sal Volatile	<i>Ammonium Carbonate</i>
Salmiac	<i>Ammonium Chloride</i>
Salt, Herapath's	<i>Quinine Iodo-sulphate</i>
Salt of Lemon	<i>Potassium Oxalate (generally with some admixture, as Cream of Tartar)</i>
Salt of Tartar	<i>Potassium Carbonate</i>
Salt of Wormwood	<i>Potassium Carbonate</i>

Saltpetre	<i>Potassium Nitrate</i>
Scott's Dressing	<i>Ung. Hydrarg. Co.</i>
Sea Onion	<i>Squill</i>
Solution, Donovan's	<i>See Donovan's</i>
Solution, Fowler's	<i>See Fowler's</i>
Spanish White	<i>Bismuth Subnitrate</i>
Spirit of Hartshorn	<i>Liquor Ammoniac</i>
Spirit, Mindererus	<i>Liq. Ammon. Acet.</i>
Spirit of Salt	<i>Muriatic Acid</i>
Spirit. Frumenti	<i>Whisky</i>
Spirit. Lavand. Co.	<i>Tinct. Lavand. Co.</i>
Spirit. Sacchari	<i>Rum</i>
Steel Drops	<i>Tinct. Ferri Perchlor.</i>
Steel Mixture	<i>Mist. Ferri Co.</i>
Sugar of Lead	<i>Lead Acetate</i>
Sulphur Auratum	<i>Antimony Sulphide</i>
Sulphur, Milk of	<i>Precipitated Sulphur</i>
Sulphur Nigrum	<i>Sulphur, Impure (Black)</i>
Sulphur Vivum	<i>Sulphur, Impure (Black)</i>
Tartar Emetic	<i>Antim. Tart., B.P.</i>
Terra Carriosa	<i>Rotten Stone</i>
Terra Fullonica	<i>Fullers' Earth</i>
Terra Japonica	<i>Catechu</i>
Theriaca	<i>Treacle</i>
Tincal	<i>Native Borax</i>
Tinct. Meconii	<i>Tinct. Opii</i>
Tinct. Opii Camph.	<i>Tinct. Camph. Co.</i>
Tinct. Thebaici	<i>Tinct. Opii</i>
Tincture of Steel	<i>Tinct. Ferri Perchlor.</i>
Toothache Seeds	<i>Sem. Hyoscyami</i>
Torrington's Drops	<i>Tinct. Benz. Co.</i>
Tous les Mois	<i>Canna Starch</i>
Traumaticin	<i>Solution of Gutta Percha</i>
Troopers' Ointment	<i>Ung. Hydrarg. Mite</i>
Turner's Cerate	<i>Ung. Calamina</i>
Turpeth Mineral	<i>Yellow Mercury Oxy sulphate</i>
Tutty Powder	<i>Impure Zinc Oxide</i>
Uction	<i>Ung. Hydrarg. Mite</i>
Vallet's Pills	<i>Pil. Ferri, B.P.</i>
Vegetable Salt	<i>Potassium Oxalate</i>
Verdigris	<i>Cupric Oxyacetate</i>
Vermillion	<i>Red Mercury Sulphide</i>
Vitriol	<i>Sulphuric Acid</i>
Vitriol, Blue	<i>Cupric Sulphate</i>
Vitriol, Green	<i>Impure Ferrous Sulphate</i>
Vitriol, Oil of	<i>Sulphuric Acid</i>
Vitriol, White	<i>Zinc Sulphate</i>
Wade's Drops	<i>Tinct. Benzoin. Co.</i>
Ward's Paste	<i>Conf. Piper. Nig.</i>
White Copperas	<i>Zinc Sulphate</i>
White, Flake	<i>Lead Carbonate</i>
White Lead	<i>Lead Oxycarbonate</i>
White, Pearl	<i>Bismuth Oxychloride</i>
White Precipitate	<i>Ammoniated Mercury</i>
White, Spanish	<i>Bismuth Oxynitrate</i>
White Vitriol	<i>Zinc Sulphate</i>
Yellow Basilicon Ointment	<i>Ung. Resina</i>
Zinc Flowers	<i>Zinc Oxide</i>

CHAPTER LVIII

THE COLLECTION OF MEDICINAL PLANTS

The appended list shows the seasons at which the following plants should be collected :

Aconite	June
Belladonna	June to August
Black Currants	When ripe
Broom	June and July
Colchicum (flowers)	September and October
„ (corms)	Before flowering
Coltsfoot	July to September
Cotyledon	April and May
Dandelion (root)	October to March
„ (flowers)	April and May
Elder (leaves)	May to September
„ (flowers)	June and July
Foxglove	May and June
Goose-grass	June
Hemlock	May and June
Henbane	May and June
Lactuca Virosa	May and June
Laurel (leaves)	October to May
Lily of the Valley (flowers)	April and May
„ (root)	February to May
Mulberries	August
Pansies	May to August
Raspberries	July
Red Poppy (flowers)	June and July
Roses	June and July
Savin	October to May
Stramonium	September

Vegetables intended for pharmaceutical operations should be gathered in dry weather. They should also be collected annually, and not kept more than a year.

The following rules for the collection and preservation of vegetable substances may be generally followed :

Roots and rhizomes should be dug up when the old leaves and stalks have fallen off, and before the new ones have shot out.

Herbs and leaves should be gathered after the flowers have opened, but before the seeds have ripened.

Flowers only when freshly blown.

Fruits and seeds as soon as they are fully ripe.

All parts of vegetables, unless otherwise directed, should be kept in a dry state. The drying may be effected either by exposing them on netting to the heat of the sun, or they may be placed in the drying cupboard, which should be kept at a temperature of about 40° C.

Average Loss on Drying

Belladonna (leaves)	80 per cent.
„ (root)	60 „
Colchicum corms	65 „
Conium leaves	78 „
Digitalis leaves	80 „
Henbane	80 „
Squill	75 „
Taraxacum	75 „

CHAPTER LIX

POISONS

The dispensing and selling of poisons is one of the most important functions of the legally qualified pharmacist. By the Pharmacy Act of 1868 it is unlawful for any person, not being a pharmaceutical chemist or chemist and druggist within the meaning of the Act, to sell or keep open shop for the retailing, dispensing, or compounding of poisons described in the schedule. As the law has placed pharmacists in such a responsible position, it behoves them to see not only that all the provisions of the Act are duly observed, but that in all dealings of which poisons form a part the greatest care is exercised.

Precautions required by the Pharmacy Act, 1868, to be observed in selling by retail, and in dispensing poisons

All the articles named or referred to in the list, both in Part I and Part II, are *poisons* within the meaning of the Pharmacy Act, 1868.

SALE BY RETAIL

I. *Relating to Part I and Part II of the list.*—It is unlawful to sell any 'poison' by retail unless the vessel, wrapper, or cover in which it is contained be distinctly labelled with *the name of the article*, the word *Poison*, and *the name and address of the seller*. This applies to all the articles in both parts of the list.

II. *Relating to Part I only.*—It is unlawful to sell by retail any poison included in Part I of the list to any person unknown to the seller, unless introduced by some person known to the seller; and on every sale of any such article the seller shall, before delivery, make or cause to be made an entry in a book, to be kept for that purpose, of—

- (1) The date of sale;
- (2) The name and address of the purchaser;
- (3) The name and quantity of the article sold; and

(4) The purpose for which it is stated to be required; to which the signature of the purchaser, and of the person, if any, who introduced him, shall be affixed. *The article must also be labelled with the name of the article, the word 'Poison,' and the name and address of the seller.*

III. *Relating only to arsenic and its preparations.*—It is unlawful to sell arsenic or any of its preparations unless, in addition to all the foregoing regulations, the following provisions of the Arsenic Act be also observed :

(1) That the poison, if colourless, be mixed with soot or indigo, so as to colour it ;

(2) That the person to whom the poison is sold or delivered be of mature age ;

(3) That the occupation as well as the name and address of the purchaser be entered in the poison book.

Dispensing.—None of the foregoing regulations applies to any article when forming part of the ingredients of any medicine dispensed by a registered chemist and druggist ; but it is necessary, if a medicine contain a poison included in Part I or Part II of the list, that the ingredients of the medicine, together with the name of the person to whom it is sold or delivered, be entered in a book kept for that purpose (*Prescription Book*), and that the name and address of the seller be attached to the medicine.

Re-copying of prescriptions containing scheduled poisons.—It is not considered to be absolutely necessary to re-copy such prescriptions each time they are dispensed, *but it is necessary* to enter the number of the prescription, name, date, and address of the patient each time, in order to comply with the foregoing, and for this purpose a special register should be kept.

List of Poisons within the meaning of the Act

PART I

Not to be sold unless <i>the purchaser is known to, or is introduced by some person known to, the seller ;</i>	ACONITE and its preparations
also entry to be made in Poison Book of	ALKALOIDS : all poisonous vegetable alkaloids and their salts
(1) <i>Date of sale ;</i>	ARSENIC and its preparations
(2) <i>Name and address of purchaser ;</i>	ATROPINE and its preparations
(3) <i>Name and quantity of article ;</i>	CANTHARIDES
(4) <i>Purpose for which it is wanted ; attested by signature ;</i>	COCAINE and its salts
and must be labelled with—	CORROSIVE SUBLIMATE
(1) <i>Name of article ;</i>	EMETIC TARTAR
(2) <i>The word ' POISON ' ;</i>	ERGOT OF RYE and its preparations
(3) <i>Name and address of seller</i>	PICROTOXIN
	POTASSIUM CYANIDE and all metallic cyanides and their preparations
	PRUSSIC ACID and its preparations
	SAVIN and its oil
	STRYCHNINE and its preparations

PART II

Must be labelled with—

- (1) *Name of article ;*
- (2) *The word ' POISON ' ;*
- (3) *Name and address of seller*

ALMONDS, ESSENTIAL OIL OF (unless deprived of prussic acid)
 BELLADONNA and its preparations
 CANTHARIDES, tincture and all vesicating liquid preparations of
 CARBOLIC ACID, liquid preparations of, and homologues
 CHLORAL HYDRATE and its preparations
 CHLOROFORM
 COCAINE, preparations of
 CORROSIVE SUBLIMATE, preparations of
 DIGITALIS and its preparations
 MERCURIC IODIDE
 MERCURIC SULPHOCYANIDE
 MORPHINE, preparations of
 NUX VOMICA and its preparations
 OPIUM and its preparations, and preparations of poppies
 OXALIC ACID
 PRECIPITATE, RED (red oxide of mercury)
 PRECIPITATE, WHITE (ammoniated mercury)
 STROPHANTHUS and its preparations
 VERMIN KILLERS, if containing a poison within the meaning of the Act

Recommendations in regard to the Sale of Dangerous Articles not Scheduled as Poisons

The following articles have been submitted to the Privy Council from time to time with a view to their addition to the Poison Schedule. Although the official sanction of the department has not been accorded, chemists and druggists are strongly recommended to adopt special precautions when dealing with these articles, in order that cases of accidental or intentional poisoning may be prevented :

ACETANILIDE
 AMYL NITRITE
 BUTYL CHLORAL HYDRATE
 CALABAR BEAN and its preparations
 CANNABIS INDICA and its preparations
 COLCHICUM and its preparations
 DERIVATIVES (poisonous) of vegetable alkaloids and their salts
 ELATERIUM and its salts
 GELSEMIUM and its preparations
 PHENACETIN
 PHENAZONE

SALTS (soluble) OF OXALIC ACID
STRONG HYDROCHLORIC ACID
STRONG NITRIC ACID
STRONG SULPHURIC ACID
SULPHONAL
VERMIN KILLERS containing free phosphorus

In addition to the above, there are other dangerous articles—such as strong solution of ammonia, lead plaster, potassium bichromate, zinc sulphate, zinc chloride, phosphorus preparations, etc., etc.—which also demand special precautions on the part of registered chemists.

Regulations for the Keeping, Dispensing, and Selling of Poisons

The following, having been prescribed by the Pharmaceutical Society of Great Britain with the consent of the Privy Council, form part of the Pharmacy Act, 1868, by virtue of the Provisions of Section 1 of that Act :

1. That in the keeping of poisons each bottle, vessel, box, or package containing a poison be labelled with the name of the article, and also with some distinctive mark indicating that it contains poison.

2. Also that in the keeping of poisons each poison be kept on one or other of the following systems, viz. :

(a) In a bottle or vessel tied over, capped, locked, or otherwise secured in a manner different from that in which bottles or vessels containing ordinary articles are secured in the same warehouse, shop, or dispensary ; or

(b) In a bottle or vessel rendered distinguishable by touch from the bottles or vessels in which ordinary articles are kept in the same warehouse, shop, or dispensary ; or

(c) In a bottle, vessel, box, or package kept in a room or cupboard set apart for dangerous articles.

3. That in the dispensing and selling of poisons all liniments, embrocations, lotions, and liquid disinfectants containing poison be sent out in bottles rendered distinguishable by touch from ordinary medicine bottles, and that there also be affixed to each such bottle (in addition to the name of the article, and to any particular instructions for its use) a label giving notice that the contents of the bottle are not to be taken internally.

Experience has taught that the greatest safety is obtained by keeping all poisons and potent remedies in a cupboard by themselves. As an extra safeguard this cupboard may be kept locked, and a bell so arranged that an alarm is given each time of opening. In establishments where two or more dispensers are kept, no poisons should ever be dispensed or sold without the presence of a qualified witness, whose duty it should be to make a note, in a book kept for the purpose, of the

name and amount of medicament, the number of the prescription, with both his own and the dispenser's initials. It is impossible to bestow too much care on the keeping and dispensing of poisons, and in every case of doubt the dispenser should, no matter at what cost of time and trouble, assure himself that he is carrying out the *intention* of the prescriber.

A copy of the poison schedule should be hung in the immediate vicinity of the poison cupboard, as well as a table of antidotes for the more commonly occurring poisons, so as to be provided for all cases of emergency.

In retailing poisonous substances it is always better to err on the side of caution. Although all the poisons in the schedule *may* be sold if the legal requirements are fulfilled, yet it is the duty of a pharmacist to supply them *only when he can reasonably assure himself that they are to be used for legitimate purposes.*

POISONS AND THEIR ANTIDOTES

In case of poisoning, first send for a medical man; then administer an emetic, unless corrosive acids or strong alkalies are known to have been swallowed. The safest emetics are :

1. One tablespoonful of common salt in a tumbler of warm water.
2. One tablespoonful of mustard in a tumbler of warm water.
3. One to two tablespoonfuls of ipecacuanha wine.
4. Thirty grains of zinc sulphate in half a tumbler of warm water.
5. One-tenth grain of apomorphine hydrochloride injected hypodermically.

Stomach syphon.—This consists of soft rubber tubing about half an inch in diameter and six feet in length. One end is oiled and passed down the gullet into the stomach; the other end being raised above the patient's head, the tube is filled with water by means of a funnel, pinched tightly to prevent the water escaping, and lowered, when, on relaxing the pressure, syphoning commences. After evacuation of the stomach, the operation should be repeated if necessary.

A stomach syphon must not be used in cases of poisoning with corrosive acids or alkalies, on account of the danger to the injured membrane.

Acid, Carbolic; Carbolic Dis-infectants	Wash out stomach with soft rubber syphon. Give large doses of olive or any bland oil. The whites of several eggs beaten up in a little water. Afterwards brandy and spirit of sal volatile.
Acid, Oxalic; Oxalates.	Stomach syphon dangerous unless used very carefully and without appreciable loss of time. Give calcium chloride or chalk, whiting, or magnesia as for mineral acids. Soda or potash useless owing to formation of soluble salt.
Acid, Prussic, and Cyanides.	A mixture of ferric chloride, ammonia, and water; brandy. Artificial respiration. Oxygen.
Acids, Corrosive Mineral	Chalk, whiting, or magnesia in water—or wall plaster or whiting from ceiling. Sodium bicarbonate or washing soda less useful on account of the gas evolved. Afterwards milk, olive or any bland oil; boiled oatmeal or linseed gruel. <i>Do not use Stomach Pump or Syphon.</i>
Aconite	Emetic; animal charcoal in water; stimulants—brandy, ether, ammonia. Hot-water bottles to feet and chest.
Alkalies: Ammonia, Potash, Soda	Vinegar; citric or tartaric acid; lemon juice. Milk, olive oil, white of egg, linseed tea or oatmeal gruel. Brandy. <i>Do not use Stomach Pump or Syphon.</i>
Antimony Salts	Emesis generally produced. Give copious draughts of warm water; tannic acid, strong tea (<i>boil</i> the leaves to extract the tannin); white of egg. Brandy, spirit of sal volatile.
Arsenic Compounds: Weed Killers, Sheep Dips	If strongly caustic weed killer has been taken, treat first for the alkali (<i>q.r.</i>). If simple arsenical poisoning, use stomach syphon or give emetic; ferric hydrate (calcined magnesia added to ferric chloride); dialysed iron, milk, white of egg, magnesia. Oatmeal gruel, linseed tea.
Atropine	<i>See BELLADONNA.</i>

Barium Salts	Epsom or Glauber's salt in water; emetic.
Belladonna	Stomach syphon or emetic; 20 gr. tannic acid, strong tea made by <i>boiling</i> the leaves; charcoal and water; hypodermic injection of $\frac{1}{4}$ gr. pilocarpine nitrate. Artificial respiration. Oxygen.
Cantharides	Emetic <i>at once</i> . Empty stomach by means of soft tube. Proceed very carefully if there is blistering. Opium, morphine subcutaneously. Linseed tea, oatmeal gruel.
Chloroform; Chloral	Stomach tube, emetic, fresh air, artificial respiration, oxygen. Amyl nitrite inhalation; 10 min. of solution of strychnine hydrochloride 1 per cent.
Colchicum; Conium	Emetic, egg albumen, tannic acid, strong tea.
Copper Salts: Verdigris, Blue Vitriol	If vomiting has not occurred, use stomach syphon. Give 10 gr. potassium ferrocyanide in a little water. Give chalk or magnesia, milk, and white of egg. Poultice abdomen.
Digitalis	Stomach syphon or emetic; 20 gr. tannic acid or very strong tea made by <i>boiling</i> the leaves; animal charcoal in water.
Eserine	Stomach tube or emetic; tannic acid.
Fungi	Stomach tube or emetic; treat on general principles.
Gases: Coal Gas, Sewer Gas, Nitrous Fumes, etc.	Artificial respiration; oxygen; treat on general principles.
Henbane	As for Belladonna.
Iodine	30 gr. sodium sulphite or common 'hypo' in water; two or three teaspoonfuls solution of saccharated lime in water; mucilage of starch, tragacanth, or arrowroot; linseed tea, etc.
Lead Salts	Epsom or Glauber's salt in water. Stomach tube; emetic.
Mercury Salts: Corrosive Sublimata, White or Red Precipitate	Emetic; stomach tube; copious draughts of milk; white of egg beaten up in milk.
Opium: Morphine, Chlorodyne, etc.	Stomach tube, emetic; potassium permanganate (10 gr. in a pint of water). Brandy, ether, ammonia, strong coffee. Keep patient moving, and stimulate body. Artificial respiration.
Phosphorus: Rat Paste	Stomach tube; emetic; 2 gr. copper sulphate in a little water. Half a teaspoonful of <i>Sanitas</i> in water at intervals of twenty minutes <i>for first hour</i> . Copious draughts of milk. <i>Avoid oil</i> .
Silver Salts	A tablespoonful of common salt in warm water both as an antidote and as an emetic; white of egg. Milk.
Strychnine: Vermin Killer	Prompt emetic or use of stomach syphon; 20 gr. tannic acid in water; very strong tea made by <i>boiling</i> the leaves; a draught containing potassium bromide 1 dr., chloral hydrate 20 gr. Chloroform inhalation between spasms; amyl nitrite inhalation between spasms or subcutaneously.
Zinc Salts	Sodium or potassium bicarbonate in water; soap solution; tannic acid; copious draughts of milk.

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